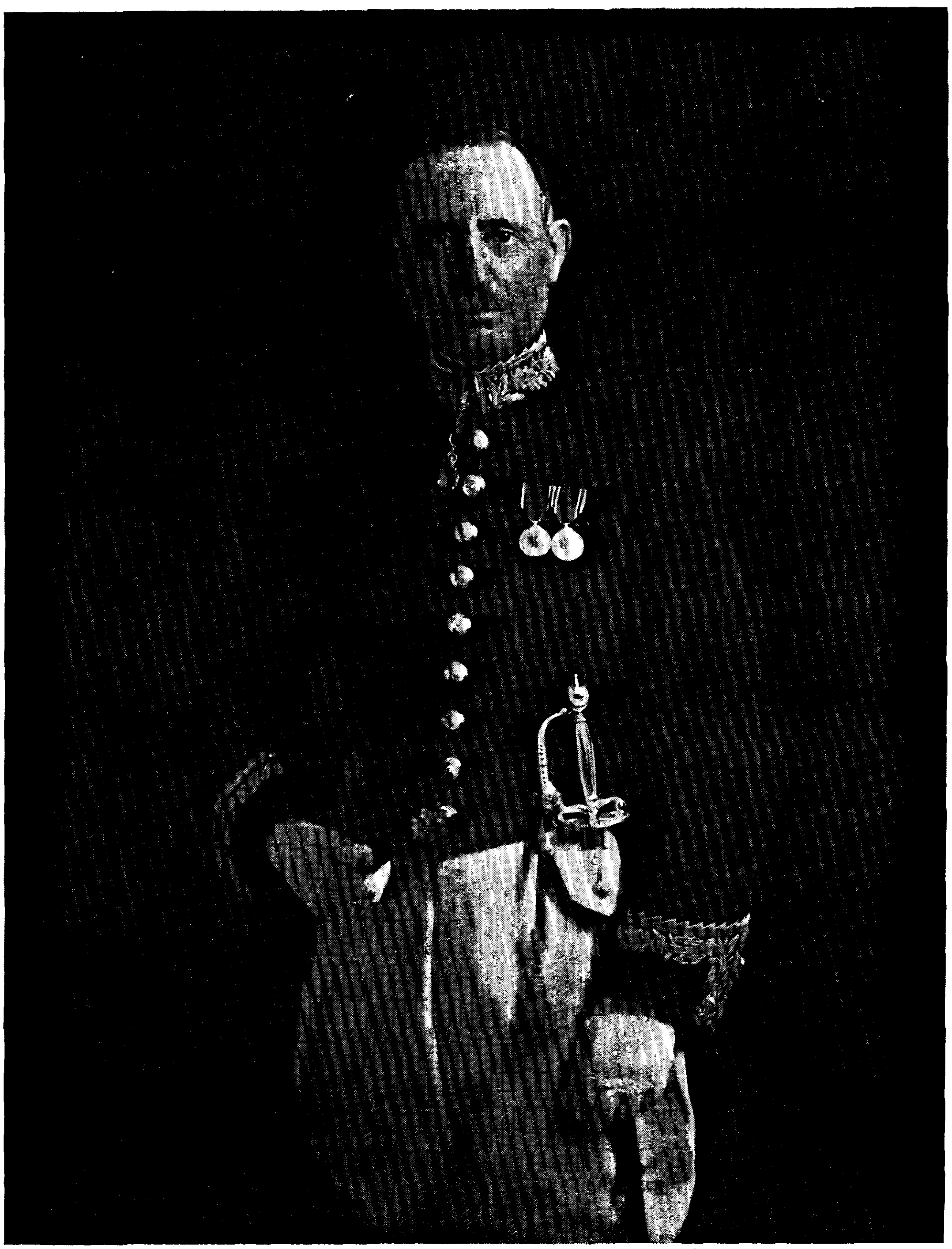

GERALD TREVOR.

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EDITORIAL

SIR GERALD TREVOR. C.I.E.,

Inspector-General of Forests and President, Forest Research Institute and College, Dehra Dun,

November 1933 *to November* 1937.

On the departure of Sir Gerald Trevor on four months' leave preparatory to retirement, India loses one of the most eminent of a long line of Cooper's Hill trained forest officers who have risen to the highest post in the service. He arrived in India in 1903 and he has thus completed 34 years of active service in this country.

During his time, far-reaching changes have taken place both in the administration and management of the Indian forests. No single officer perhaps has made a greater contribution to the striking progress in the development of scientific forestry in this country than Sir Gerald.

As examples of his work in this direction may be instanced his Working Plan for the Kulu forests which marked an important advance in the application of scientific management to the coniferous forests of the west Himalayas while his " Practical Forest Management," prepared in collaboration with Smythies, and " Manual of India Silviculture," written in collaboration with Champion, now in the press, are likely for many years to be the standard text-books for foresters in this country.

Reference may also be made to his pioneer work in the United Provinces as Conservator of the Working Plans and Research Circle. It was at the instance of Sir Peter Clutterbuck,

the then Chief Conservator of the United Provinces, that Trevor, a Punjab forest officer, was selected to take charge of and to organise this newly created Circle.

From the United Provinces, on the decision of the Government of India to train its officers for the I.F.S. at Dehra Dun, Trevor was transferred in 1926 to the Forest Research Institute as its first Vice-President and Professor of Forestry. Trevor returned to his old province—the Punjab—in 1930 as Chief Conservator. Here he remained until, on the retirement of Blascheck, he returned to Dehra Dun as Inspector-General of Forests and President, Forest Research Institute and College.

During his four years tenure of this post, he visited practically all the principal forest tracts and his inspection notes on these tours have been of invaluable assistance to a wider range than most of the local forest officers.

Keenly interested in research, the value of his work in widening the scope of the activities of the Forest Research Institute will be increasingly realised in the years to come.

He had, too, the unique honour of representing India at the Empire Forest Conferences in Canada, 1923, Australia and New Zealand in 1928, South Africa in 1934, International Union of Forest Research Organisations and International Forestry Conference, Budapest, in 1936, and the British Commonwealth Scientific Conference, London, in 1936.

Sir Gerald won the lasting regard of all members of the Forest Services. Wherever he is and whatever he does we shall remember him and we wish him and the members of his family all things fair and fortunate.

COLLETT'S FLORA SIMLENSIS

By R. N. Parker, I.F.S.

Abstract—A few species found in the Simla neighbourhood are mentioned as having been omitted from Collett's Flora Simlensis and as they are not numerous it is concluded that the Flora was reasonably complete. Changes that have taken place in the vegetation are the disappearance of the more ornamental plants due to picking flowers and digging up roots. Additions have occurred owing to exotic weeds and garden plants becoming established of which a list is given.

The Flora Simlensis, by Col. Sir Henry Collet, is, I believe, the earliest attempt made to produce a complete flora for a small area in India. It is of considerable interest in enabling one to follow some of the changes that have taken place in the vegetation since about the years 1885-1886. The flora is naturally not complete, as in such broken country it would be very difficult not to overlook a good many species and it is surprising that the omissions are not more numerous. Amongst trees and shrubs I have only noted the following omissions :

Holboellia latifolia Wall. Jutogh. A species found locally in moist ravines.

Hypericum hookerianum W. & A. var *leschenaultii* near Narkanda, not common.

Caragana sukiensis C. K. Schn. Giri valley. A local plant described since Collett's time.

Strobilanthes wallichii Nees. Kufri and Catchment Area. Flowers at intervals of 12 years and hence easily overlooked.

Engelhardtia colebrookeana Lindl. Sabathu. A plant usually very local.

It will be seen that the omissions are few and easily explained. The few omissions amongst herbaceous plants that I have noticed appear to be equally unimportant and I think one may safely assume that any plants now common in Simla but not noted by Collett have appeared since his time.

A number of plants have been included in the flora on account of their distribution. When a plant was known to occur in Kumaon and Kashmir, it has been assumed that it will be found in the Simla

District. This assumption is not justified since Collett does not include any portion of the dry inner Himalaya in his area. It is naturally not possible to prove that any given plant does not occur, but it is very unlikely that plants such as *Silene griffithii* and *Hippophae salicifolia* and others will be found near Simla.

The changes that have taken place since 1885 are both losses and gains. The only losses that can be detected have occurred amongst the more beautiful flowering species and are due to ruthless destruction by vandals who doubtless consider themselves "flower lovers." This type of destruction is still going on but it is not new. The following quotation from "Simla Past and Present," by Sir Edward Buck, is illuminating. The Hon'ble Emily Eden, sister of Lord Auckland (then Viceroy), thus wrote in 1838-39:

> "We pass our lives gardening. We ride down into the valleys and make the syces dig up wild tulips and lilies and they are grown so eager about it that they dash up the hill the instant they see a promising-looking plant and dig it up with the best possible effect except that they invariably cut off the bulb."

A century of this sort of "gardening" has naturally had its effect on any species of unusual beauty. Collett states that *Habenaria susannae* was nearly extirpated near Simla in 1886. I have only seen it once and that 20 years ago. Collett mentions *Lilium polyphyllum* as being common. In recent years I have only seen it twice but in both cases on passing the spot a day or two later I found that others had also noticed it and the plants had gone.

As regards the gains to the flora, these are due to exotic weeds becoming established and to garden plants beginning to run wild. Some garden plants such as Coreopsis, Cosmos and Tropaeolum are often seen growing near gardens, but I do not think they can maintain themselves permanently and hence cannot be counted as naturalized. *Acacia dealbata* when planted spreads by rootsuckers, but it is doubtful if seedlings ever become established. I have seen natural

seedlings of ***Cupressus lusitanica*** Mill, on Prospect Hill and two seedlings of ***Trachycarpus excelsa*** H. Wendl. (or ***T. takil*** Becc. if this is really distinct) in the Glen, but these can hardly be considered naturalized as yet.

Lepidium ruderale Linn.—A weed of gardens and roadsides, common. Simla, Kasauli.

Saponaria officinalis Linn.—Kasauli. In Simla it is cultivated and sometimes seen as an escape near gardens. Would probably be common if less conspicuous.

Oxalis latifolia. H. B. K.—Has been an abundant weed in Simla for the past 20 years. It is spread with plants carried from Simla for planting elsewhere.

Oxalis tetraphylla.—Cav.—Twenty years ago this plant had started to invade Simla West from Summer Hill. Now it is found all over Simla and has replaced *O. latifolia* on some banks as it is a taller plant and more vigorous except on shallow soil.

Oenothera rosea Linn.—Collett says that several species of Oenothera have become naturalized about Simla but does not mention the species. *O. rosea* is now one of the commonest plants in Simla and occurs throughout the district at suitable elevations. It is unlikely that Collett would have omitted it if it had been as abundant in 1886.

Oenothera tetraptera Cav.—Common near Sanjauli on very shallow rocky soil. Not conspicuous as the large white flowers do not open till dusk.

Stevia ovata Lag.—Abundant near Annandale but has spread very little during the past 20 years.

Tridax procumbens Linn.—Very common in the low hills ascending to 6,000'. This species appears to have spread considerably in N. W. India during the past 30 years and is still extending its range.

Dahlia variabilis Desf.—Naturalized at Kasauli and said to have been formerly common at Simla. Now found naturalized only near gardens. It is probably too much picked and dug up to become established near Simla.

Zinnia pauciflora Linn.—Naturalized on warm slopes especially at 3,000 to 5,000′. Popularly this is supposed to be the garden zinnia run wild.

Erigeron mucronatus Dc.—On walls near Annandale but not common.

Chrysanthemum leucanthemum Linn.—Fairly common on hot dry grassy slopes, but not as abundant round Simla as it is near Dalhousie and Murree.

Erigeron canadensis Linn.—A plant that has been much confused with *E. linifolius* Willd. Collett's description of the latter and the remark "A garden escape" apply better to *E. canadensis*. Both are common especially *E. linifolius* which appears to be an indigenous species and not an escape.

Vinca major Linn.—Naturalized on shady banks in Simla.

Solanum pseudocapsicum Linn.—Frequently seen growing spontaneously below Simla.

Linaria cymbilaria Mill.—Common on walls in Simla. Also established at Naini Tal, but I have not seen it in other hill stations.

Digitalis purpurea Linn.—Naturalized in ravines below Simla at 5 to 6,000′ and locally abundant. Heavy grazing appears to favour this plant as it is not eaten by cattle.

Lantana camara Linn.—Sabathu. Abundant in the low hills and spreading as a result of over grazing.

Salvia leucantha Cav.—A recent introduction. Has been much planted in Simla gardens and has started to spread at Kasauli. A few natural seedlings have also been observed in Simla.

Boussaingaltia basellcides H. B. K.—Naturalized at one place in Kasauli. Spreads by the bulbils becoming detached and taking root.

Hemerocallis fulva Linn.—Simla, Kasauli, etc. Easily grown and spreads apparently by suckers.

Zephyranthes carinata Herb.—Naturalized at Kasauli and Sabathu.

Zephyranthes candida Herb.—Naturalized at Junga and Tara Devi.

Bromus unioloides H. B. K.—One of the commonest grasses in Simla. Also seen in Jutogh. It is likely to spread more widely in time.

The above list omits succulents. Collett under ***Euphorbia royleana*** mentions ***Opuntia dillenii*** Haw. as being seen in hedges near Simla. This plant being the only member of the genus mentioned in the Flora of British India has been used to mean any species of Opuntia. If it occurs at all it is much less common than other species and there can be little doubt that the species intended was ***O. monacantha*** Haw. ***O. stricta*** Haw. is common near Sabathu and the plant usually called ***O. ficus-indica*** Mill. is also occasionally seen. ***Agave cantula*** Roxb. is seen in hedges at the lower elevations. ***Agave wightii*** Drumm. and Prain is common near Sabathu and the plant usually called ***Agave americana*** Linn. is seen up to 7,000′ or more, planted for ornament or in garden hedges. These succulents can only be considered as naturalized in occasional very small areas. They spread by vegetative reproduction and not by seed.

SILVICULTURAL EXPERIMENTS

By J. Banerji, I.F.S.

Abstract—The present system of "Paired Plots" is examined and is considered unsatisfactory; if used, Fisher's t-method, or Mahalanobis' f-table should be used for computation of significance. A system of Randomized Blocks is recommended for silvicultural experiments. After analysis of Variance, Fisher's z-table or Mahalanobis' x-table should be employed for testing significance of results. A plea is made out for more detailed, well-laid-out and complicated experiments.

Experimental technique in silvicultural researches in India is still undeveloped. With the advent of "Experimental Manual," no doubt, the standard of experiments rose to some extent, but, it is six years since the book was published and remembering the elegant and delicate methods at our disposal now—specially in the analysis of Co-variance—it cannot be said that full use has been made of them all in the different Provinces.

Before the days of experiments, observation in the field was the basis of all management. The recorded opinion of the observer was accepted with little challenge. As is usual in such cases, an enormous

amount of personal bias was involved in these teachings and they were forced down on a succession of scientists. Like every other science, progress was made—but slowly and by laborious methods of trial and error; traditions of correct practice were developed only empirically in course of time. Forestry still clings to many such old traditions and generalisations, which will not probably stand the test of critical examination.

In all properly conducted silvicultural experiments, the worker is faced with many peculiar difficulties, of which the most important and the most baffling is the soil heterogeneity. A physicist, or a chemist, or an astronomer gazing through his telescope, is unaware of this problem. He is mostly involved with his instrumental error, personal equation, and his experimental conditions. The agriculturist is the only other worker who has to face the same trouble, and he has tried to solve it in very ingenious ways. The silviculturist's soil problems are at par with the agriculturist's; if not, they are a little more difficult.

The inherent soil fertility, which affects all growth, is unfortunately not constant. It varies in a baffling manner from inch to inch with every change in the micro-relief. Even if the experimental plots are made long and narrow, as is often done, and brought close to each other, they are nevertheless on different sites with probably different fertility. The measurable effect of any treatment will therefore be subject to errors due to this cause alone. It has been seen that with proper layout of the experiment, namely, by judiciously choosing the site, size, shape, and arrangement of the plots, these errors can not only be minimised, but also be estimated sufficiently accurately. Complete elimination of errors due to soil heterogeneity is impossible and need not be attempted.

Though very often we find a distinct drift or gradient from high to low fertility across a field, yet in selecting a site for experimental plots, we have to be prepared and make suitable allowances for a random distribution of soil fertility. To meet this distribution, the silviculturist tries to distribute his treatments in such a way that

each shall have an equal chance of experiencing all varying grades of soil heterogeneity.

One such effort is the "Paired Plot" system and is often employed when only two treatments are to be compared. The plots are laid out in long strips across the field in the order A, AB, BA, AB, BA, AB, BA, A, with as many replications as desired. This is a rudimentary type of experiment and the computation of result is frequently done with the help of Bessel's method. The means of the two treatments with their probable errors (or standard errors) are first determined in the usual way. Then the probable error (or standard error) of the difference of the means is calculated. If the ratio of the difference of the means to its probable error (or standard error) is more than 3·2 (or 2, if standard error is used), the difference is said to be statistically significant. In this calculation we make use of the important proposition that the variance of the difference of two *independent* variates is equal to the sum of their variances. But in field trials, the variates are not independent ; there is often a high correlation between the fertility of adjacent plots. This method, again, is only applicable when the sample is large, which is usually not so in field trials. It is therefore a mistake to use this computation in silvicultural experiments, though it is still very often done.

"Student's" method of z can be applied with some advantage in computation of "Paired Plot" experiments. It involves computing a quantity z defined as follows :

$$z = \frac{M_d}{s},$$

where M_d is the mean difference and "s" is the standard deviation of the difference of two samples.

or,

$$z = \frac{M_d}{\sqrt{\frac{S(d^2)}{n}}}$$

where $S(d^2)$ stands for sum of squares of the deviations from the mean, and "n" is the size of the sample.

"Student's" original table of "z" is now consulted (available in Biometrica, Vol. VI, or in Pearson's Tables, Vol. I), which gives the significance of observed difference for known values of "z" and "n".

" Student's " table for " z " is, however, acceptable for large samples ordinarily.

The third and the most acceptable method of treating " Paired Plots " is to calculate the significance from Fisher's t-table, applying the requisite degrees of freedom. This is applicable to small samples too. If a sample of " n " values of a variate " x " is available, then we can test whether the mean of " x " differs significantly from zero by calculating the following statistics :

$$\bar{x} = \frac{1}{n'} S(x)$$

$$\frac{s^2}{n'} = \frac{1}{n'(n'-1)} S(x-\bar{x})^2,$$

$$t = \bar{x} \div \sqrt{\frac{s^2}{n'}}$$

$$n = n' - 1$$

The distribution of " t " for random samples of a normal population distributed about zero as mean is given in Fisher's t-table for each value of " n " up to 30 and then infinity. From this table we get " P," the probability of falling outside the range $\pm t$, and if this probability is low, say ·01 to ·05, we can assume that the result is significant statistically.

A distinction in Fisher's t-method can be made when the observations can be paired and when not. Assuming that there is a correlation between adjoining plots, we can apply t-method for " Paired Plots." When observations are independent, Fisher's t-table can still be used, but a different set of statistics are to be calculated (see 24·1, Fisher's Statistical Methods for Research Workers), depending on the degrees of freedom. Prof. P. C. Mahalanobis has recently published a table showing the distribution of a quantity " f " at various levels of significance. This table can be used when testing the significance of differences between independent samples.

With more than two treatments, replication and randomization is essential. The standard error of the mean is furnished by the well-known formula—$\sqrt{\frac{S}{n}}$—which shows that the decrease in the standard error of the mean of one treatment is proportional to the square root

of the number of replications. Hence with the increase of replications, accuracy is improved.

One primary condition for an experiment is that we have to isolate the factor under test and be sure that any significance established is for this factor only; in all other factors the plots should be as much alike as possible. To analyse the Variance statistically, it is also essential that the plots averaged shall be independent of one another and independent of any other treatment. If an unbiassed estimate is wanted, each set of plots should be a truly random sample of the universe; these are the fundamental hypotheses upon which the principles of statistical analysis are based. The necessity for randomization is therefore clear.

For the complicated experiments conducted by silviculturists choice of design lies between the Latin Square and Randomized Blocks. A Latin Square (not necessarily a square, geometrically) allows for fertility trends in two directions and should give a lower experiment error. This is suitable for testing significance of different kinds of weeding treatments. But for three treatments, it gives only two degrees of freedom for error and is not consequently very sensitive. Even with four treatments, accuracy is not very great. With a larger number, the layout becomes large and cumbrous, with an added disadvantage in the inaccessibility of the middle plots.

A Randomized Block, on the other hand, does not suffer from any of these disadvantages. There are many possible arrangements of plots and one for four treatments with ten replications is shown below :

I	II	III	IV	V	VI	VII	VIII	IX	X
A B C D	BDCA	CABD	ADBC	DACE	CDAB	BCAD	CBDA	DCBA	CADB

The treatments are A, B, C and D. They can be randomized in one of the many possible ways within the ten blocks. Each plot is open at either end and is therefore easy for inspection. If the layout is considered too long, the blocks can be massed together to

form a sort of a square. Such randomized block arrangement is suitable to test the significance of different root lengths for stump planting, or of different times of planting with different diameters and root lengths. There are limitless ways of variation and this freedom is a desirable quality in a layout. If a more complicated experiment is required, the plots within a block can again be divided into a suitable number of sub-plots. If, say, it is desired to test planting of three root lengths of teak stumps at four different dates with six replications, the blocks will first be divided into three randomized plots for root lengths and each of these plots will again be sub-divided into separately randomized four sub-plots for dates. In all there will be 72 sub-plots and the computation, too, is not difficult. It is therefore desirable and probably essential in silvicultural experiments, whenever there are more than two treatments to be compared, to use randomized blocks in the design. The present practice of laying out plots in the order ABC, CBA, ABC, CBA . . . or ABCD, DCBA, ABCD, DCBA. . . . or ABCDE, EDCBA, ABCDE, EDCBA . . . . , etc. is defective and computation of results in these experiments by Bessel's method is inadmissible. With these arrangements, "we have no guarantee that an estimate of the standard error derived from the discrepancies between parallel plots is really representative of the differences produced between the different treatments; consequently no such estimate of the standard error can be trusted, and no valid test of significance is possible" (R. A. Fisher).

In all such cases insistence must be laid on a randomized block layout and computation by Fisher's " z " test, which is based on analysis of variance. The reduction of error through elimination of block differences is considerable and errors within blocks are reduced by random arrangement of plots. In Fisher's " z " test the total variance is split up into its component parts: Blocks, Treatments and Error. When the variance due to treatments is significantly larger than that due to blocks or errors, then only we shall accept the experiments furnishing a significant result. A table in the following form is prepared for the calculation of " z " and the formula for the calculation for each row and column is furnished in the table : this

is the basis of all primary calculation and must be computed before proceeding further.

Table for analysis of Variance for " n " treatments and " k " blocks.

Variation.	Degrees of freedom.	Sum of squares.	Mean sq. Col. 3/2.	½ Log$_e$ Mean sq.
1	2	3	4	5
Blocks	k—1	$n.\ \overset{k}{\underset{1}{S}}(\bar{x}b-\bar{x})^2$	*	A
Treatments	n—1	$k.\ \overset{n}{\underset{1}{S}}(\bar{x}t-\bar{x})^2$	*	B
Errors	(n—1) (k—1)	$\overset{nk}{\underset{1}{S}}(x-\bar{x}b-\bar{x}t+\bar{x})^2$	*	C
Total	nk—1	$\overset{nk}{\underset{1}{S}}(x-\bar{x})^2$	*	

Where " S " stands for summation within limits shown, $\bar{x}b$ is mean of a block, $\bar{x}t$ is mean of a treatment, and $\bar{x}$ is experiment mean.

Now significant differences in column 4 are looked into and tested with the help of column 5, which is done by taking differences in column 5 (Fisher's " z "). If the experiment has been conducted satisfactorily, we ought to find significant difference in column 4 between treatments and errors : B—C, which is Fisher's " z," ought to show a significant difference when Fisher's z-table is looked into with the requisite degrees of freedom. His tables give the 5 per cent, 1 per cent and 0·1 per cent points of the distribution of " z." (Note : Prof. Mahalanobis' " x " test is simpler and avoids using Logarithm to the base " e.")

Having satisfied ourselves about the acceptability of the experiment as a whole, we proceed with the next stage in computation which is to find out the critical difference from Fisher's formula and apply it to differences between the mean values of the treatment. The accuracy of the experiment is shown by the standard error per

plot, furnished by the square root of column 4 in Errors row ; this is usually shown as a percentage of the experiment mean. Many variations of calculation are possible at this stage, depending on the nature of the treatments, and our desire to analyse the Co-variances. This analysis of Residual Errors furnishes excellent and interesting facts about the experiment, never thought of at the time of laying out the experiment. It is not possible here to explain the elegant tests and methods of analysis now available to the statistical worker. Those who are interested in them may refer to Fisher's "Statistical Methods for Research Workers."

Silvicultural experiments, as at present conducted in India, are simple and are concerned with only one or two treatments at a time. Even then the layout is simple and the calculation of significance usually unacceptable. This idea that experiments should be simple was regarded as important by scientists generally until very recently.

The tendency to-day is in favour of complicated and well designed experiments, comparing a number of treatments and variations and giving results of wide applicability. Methods of calculation, too, tend towards clarity and elegance. Considerations of space, design, and gathering of data, have a check on this tendency, but workers are generally very enthusiastic about large plots.

Many practical men laugh at the modern refinements of field experiments on the ground that they are unduly sensitive and try to measure differences which are so small they do not matter at all. They should remember that if the methods are capable of measuring small differences, they are still more trustworthy when large differences are concerned. Thinking in terms of "Trial and Errors" method is, no doubt, easy, but involves many uncertainties and delays. It is almost like hit or miss in aiming. On the other hand, "Confounding" or "Incomplete Block Experiments," which is a feature of many well designed modern field experiments, furnishes a surprising amount of unbiassed facts about the experimental results. Figures are made to tell stories and divulge secrets which are well guarded by Nature, but are easily brought out by these statistical methods.

THE FORESTS OF UPPER ASSAM

PART II.

BY J. N. SEN GUPTA, EXPERIMENTAL ASSISTANT SILVICULTURIST, F. R. I.

(*Continued from pp.* 734—45 *of the " Indian Forester " for November* 1937.)

24. *Experiments on natural regeneration.*—The extent to which the over head cover may be reduced to establish the natural seedlings of important species and prevent their suppression by incoming weeds has not yet been carefully studied to lead to any conclusive results. Some old divisional experiments, carried out in Sylhet, to establish natural regeneration of *Dipterocarpus turbinatus* (*gurjan*) and *Eugenia jambolana* (*jam*) round their mother trees, only indicated that by making clearances and systematic weeding, complete stocking could be obtained in four to five years over 1·5 acre of *gurjan* and ·04 acre of *jam* from a single mother tree. In Lakhimpur (Jaipur reserve), the two 1929 silvicultural experimental plots and the divisional tending plots have given enough observational evidence to indicate that (*i*) weeding and gradual thinning out of interfering underwood stimulated growth of dormant natural regeneration; (*ii*) the few artificially regenerated patches also responded well to such tending operations; (*iii*) growth-vigour depended on species and frequency of weedings,—*Dipterocarpus macrocarpus* and *Shorea assamica* responding the most, species of *Magnoliaceæ* moderately and *Mesua* the least to the intensity of opening up; (*iv*) plants of these species under heavy shade are attacked by shoot-borers with resultant double or triple leaders; (*v*) the canopy should not initially be opened out too heavily whereby unestablished natural regeneration gets swamped by weed growth; and (*vi*) cultural operations carried out uniformly throughout the whole area give better results than incompletely only round groups or patches, which are uneconomic as they are difficult to control.

25. The 1936 experimental plot at Digboi has a better plan and project than the older plots and falls in a line with similar experiments of lifting the canopy from below gradually upwards, that have

yielded very good results in other provinces. Such indications were also noticeable in the subsidiary operations carried out by Mr. Simmons in the Disoi reserve in 1934, a couple of years after a light selection felling. Undergrowth was cut out in places where advance growth had already existed or seed-bearers promised new recruitment, and the lower and middle storeys thinned which together cost about Rs. 3 per acre. Results were promising but, unfortunately, no further cultural operation was done during the last three years. This procedure of lightening the canopy from below gradually upwards by removing the lower and middle storeys, with resultant beneficial effect on the natural regeneration without encouraging weed growth as long as the closeness of the overwood canopy is maintained, seemed to me a move in the right direction.

26. Contrary to the above, in the more heavily worked out forests on the foothills and plains the residual crop now consists of a poor stand of stag-headed or malformed middle-aged *hollong*, *Artocarpus chaplasha*, etc., in the topmost canopy. This condition is evident in Barrajan, *e.g.*, Compartment 7, worked in 1926-27 and since left with a standing crop of 43 trees only above 2′ in girth (of which 13 only are over 3′) with a corresponding basal area of 54 square feet only. The profuse seedlings that came in the wake of exploitation, but remained unattended till 1935, were meanwhile overrun by prolific weed growth including climbers and, worst of all, by *bojol* bamboos (*Pseudostachyum polymorphum*). This area was cleaned at a cost of Rs. 10 per acre, which exposed some 9,700 seedlings of different valuable species per acre, of which *Mesua* alone numbered over 5,700, *hollong* 3,390, *Machilus* about 400 and *Magnoliaceæ* over 100. Seedlings had broken leaders with apparent signs of long suppression and the few poles and saplings, which were present, appeared to be trying to push their heads up in their struggle for light. The heavy influx of weeds and scattered overwood markedly exhibit here, as in other provinces, the futility of any drastic opening out of the canopy from above instead of from below.

27. In every case, the bulk of natural regeneration is the advance growth already on the ground, as further evidenced from unworked

areas. While this advance growth responds to the opening of the canopy, the latter is also responsible for bringing in further recruitment in places. So the canopy treatment induces both the qualitative and quantitative progress of natural regeneration.

28. It is reported that in the Darrang evergreen forests experimental cleaning of undergrowth under mother trees of various species has shown profuse natural regeneration—about 3,300 *bonsum* (*Phœbe*) seedlings under one seed-bearer. The system of aided *natural regeneration* of *hollock* (*Terminalia myriocarpa*) by strip fellings at right angles to the prevailing wind has been very successful in Sadiya, specially at Pasighat, where the stand of *hollock* is " amazingly rich," at a cost of Rs. 15 per acre at the end of the first year, when the plants average 6′ and above in height. The initial operations of clear-felling, soil-wounding and tending are very much the same as for artificial regeneration—the only difference being natural dispersal of seeds in place of sowing.

29. So, the technique of establishing natural regeneration has yet to be standardised in the Assam valley evergreen forests. The more valuable species reproduce themselves plentifully in most of the divisions and systematic cultural operations are essential. Such tending operations entail expenditure—an aspect that looms large in the general outlook and consequent treatment of these forests. Funds have not been available for regular climber-cutting in high forest, which is the primary cultural-operation both for existing as well as for future crop. The closing down of the Naharkatiya Treating Plant has further led to stagnation of work in most of the reserves in Sibsagar and Lakhimpur. The more recent administration reports mention that so much timber comes out from unclassed state forests and tea garden grants that there is little general demand from elsewhere, and until a more sustained demand arises, permitting the profitable removal of some of the overhead canopy, progress must continue to be but slow.

30. Meanwhile, the writer may be permitted to suggest the laying out of a series of well-planned experimental plots on an approved technique with a view to find out the most economic method of raising

natural regeneration in different localities. In this the local officers may utilise the experience of their confreres elsewhere and avoid their mistakes. There are ample possibilities in Assam, locally endowed with better conditions of soil and climate as well as more abundant natural regeneration than many other places. In his article on "Regeneration of Gurjan" (*vide I. F.*, Vol. LXII, No. 12), the writer has sought to explain two apparently conflicting ideas about the intensity to which the overhead canopy should *initially* be opened out. In unworked virgin forests, the canopy has to be *lightly, but uniformly*, opened by a preparatory felling as an initial measure, but not so in systematically worked out areas (where the canopy had already been broken) except for the purpose of uniformity. Thereafter the gradual opening of canopy from the ground upwards, leaving the top canopy intact till last, has been recognised as the most acceptable method so far evolved for the gradual admission of overhead light by stages at a rate calculated to keep the rank-growth of weeds definitely in check.

31. *Artificial regeneration (plantations).*—The earliest attempts at experimental teak plantations were made by the civil administration in 1873. Schlich, in his memorandum of the same year, did not feel at all enthusiastic over them as he thought the cold dampness of Upper Assam was possibly against the growth of teak. Sporadic unsuccessful attempts followed thereafter, whose connected history is difficult to trace, till some regular attempts were made during the twenties of this century. A short *résumé* of the progressive history of the plantation work in different localities will indicate stages by which the present technique has evolved.

32. *I. Surma valley :—(i) Sylhet.*—The earliest systematic plantation, started in 1922 at Lowachera with *taungya*, has continued annually to date—the *taungya* method being supplemented, since 1924, by areas under regular *departmental* system. Out of about 75 to 100 acres taken up for plantation every year, a little over 70 per cent was worked by the agency of *taungya* while less than 30 per cent by the department. The Kamarchera and Maulvibazar plantations of later origin (since 1931) have all been worked departmentally.

Taungyas have been carried out exclusively by "Tipras" who are either regular forest villagers or outsiders persuaded to *jhum* in the reserves. They do their cultivation only for one year in the same area, and prefer to *jhum* land under bamboos that can be sufficiently cleared with the minimum trouble. In the past, they could, however, be persuaded to tend old plantations for another two years.

33. Teak and *Gmelina arborea* were the first *species* that were tried extensively for their quick growth and commercial importance. Heavy *Dihammus* attack after the first two years soon discouraged the choice of teak and *Gmelina* continued to be the principal species till 1931, along with some other indigenous species, *viz.*, *Artocarpus chaplasha*, *Cedrela toona*, *Albizzia procera*, etc., that had partial success, and a few exotics, *e.g.* *Xylia dolabriformis*, mahogany, *Terminalia tomentosa*, *khair*, etc., all of which practically failed to establish themselves. Extensive *Loranthus* attack on *Gmelina* since 1931-32 ruled out the advisability of growing it as a pure crop on any large-scale, and mixed plantations of indigenous species have since been the practice. *Lagerstrœmia flos-reginae* (*jarul*) has been introduced since 1932.

34. Wide *espacement* had to be adopted to provide favourable conditions for the *jhumias*—a factor which largely contributed to the failure and relatively high cost of plantations. Originally starting with an espacement of 20′ by 10,′ it was soon standardised at 12′ by 9′ for the *taungya* and 6′ by 6′ (occasionally 8′ by 8′ and 4′ by 4′) for *departmental* plantations. These worked out not too badly as long as quick growing *Gmelina* was the main species that started well and closed up in the third year even with 12′ by 9′ spacing. But it proved too wide for other slow-growing species introduced since 1931. It is contended that the *jhumias* are not agreeable to reduce the spacing from 12′ by 9′ but may be induced to convert this rectangular espacement to a square one of 10′ by 10′ (introduced since 1935), which is definitely better for thinning. It has also been prescribed that where pure patches of slow-growing species are aimed at, quincunx planting of the desired species (slow-grower) in the centre with *Gmelina* at the four corners (as a nurse) should be carried out. Stump planting of

one year old nursery plants is the general practice in both *taungya* and *departmental* plantations, and the method has proved successful for teak, *Gmelina*, *Cedrela toona*, *Artocarpus chaplasha*, etc. Sal and *gurjan* (*Dipterocarpus turbinatus*) have mostly been sown direct. Stumping of *gurjan* has usually failed (except a small patch in 1934 departmental plantation at Lowachera).

35. As regards tending, the first year's weeding and cleanings were done free by the *jhumias* in their *taungya* as often as required. In the *departmental* plantations, three weedings were required in the first year, one selective cleaning in the second and thereafter the plants were left to themselves. These were adequate for quick-growing *Gmelina* but proved inadequate for slow-growing species introduced later. Teak, that had been initially spaced wide apart, did not suffer much from want of early thinnings, but *Gmelina* did, and seriously too, with the result that older plantations are a very poor show specially on the upper slopes and ridges. Apart from attack by *Loranthus scurrula*, browsing and girdling by deer were also responsible for a lot of casualties in *Gmelina*, *Artocarpus*, *Cedrela*, etc.

36. (*ii*) *Cachar*.—The reserved forests are confined mostly to the inaccessible hilly areas. Long distances and absence of easy communications have been a severe handicap to the introduction of regular silvicultural methods, and it will take a long time to work these forests under any systemtic management. Early attempts at planting up worked out areas were mostly a failure and large areas of unsuccessful plantations had to be written off lately. During his last inspection (early in 1936), the Inspector-General of Forests agreed that the only practical method of regenerating these forests was by means of *compensatory plantations*, *i.e.*, " plantations established in the easily accessible but worked out parts of the reserves to compensate for the timber being removed from the rugged hinterland."

37. *II*. *Assam valley*: (*i*) *Lakhimpur*.—The first plantations worthy of mention are the *departmental* ones in the Jokai reserve that started in 1924-25 and continued up to 1930-31 with a minimum of about 6 acres to a maximum of 30 per annum. They marked two distinct stages of development,—the first being the *tunnel or avenue*

method of strip sowing, and the second the *clear-felling method* described below. (An earlier attempt to raise plantations of *Ficus elastica* and *Lagerstrœmia flos reginae* in 1913-14 by transplanting larger plants from the nursery cost enormously and failed.)

38. *Tunnel or Avenue method* (1924-26).—8′ wide strips, spaced 33′ to 36′ apart centre to centre, were tunnelled through the high (secondary) forest. The strips were cleared of all tree growth, stumps, etc., hoed and broadcasted with mixed seeds of important indigenous species, *e.g.*, *Morus*, *Cedrela*, *Artocarpus*, *Lagerstrœmia*, *Melia*, *Taraktogenos*, *Terminalia myriocarpa*, etc. (the last one being put out as a fencing along the two edges of each strip to keep deer out) and some treated seeds of teak; in-fillings were attempted with cuttings of *Morus laevigata*. The cost of formation worked out at Rs. 25 per acre with four weedings in the first year that cost another Rs. 5, excluding the cost involved in tree fellings, which was covered by sale-proceeds. These areas were looked after for the first few years, and left untended thereafter for a long time till lightly thinned and climbers cut in places during 1935-36. *Artocarpus chaplasha* and *Terminalia myriocarpa* are the only two species that have relatively succeeded in places, whereas others have practically failed; and the few teak survivals, struggling for light, are not at all promising.

39. *Clear-felling method* (1927-31).—The existing crop was clear-felled, leaving only a few odd large trees for the purpose of shade and of economy of labour,—debris burnt in February and alternate strips 8′ wide, 22′ from centre to centre (16½′ in 1927) were cleared of stumps and worked up by hoeing fully or in 4″ wide drills. Seeds of most of the above indigenous species and *Gmelina*, *sissu*, *Alseodaphne* and *Michelia oblonga* were broadcasted thickly in March. Frequent weedings (three to four times) were done that cost together Rs. 7 per acre (varying between Rs. 4 and Rs. 10) in the first year, Rs. 6 (between Rs. 3 and Rs. 9) in the second year and about Rs. 4 in the third. Operations thereafter were cleanings, climber-cutting and light thinnings as required for regular espacement. These tending operations cost Rs. 3 to Rs. 4 in the fourth year, Rs. 2 to Rs. 3 in the fifth and Re. 1 in the sixth. As viewed in January 1937, the stocking was

patchy and not very uniform. The best growth was of *hollock* (*Terminalia myriocarpa*) about 40′ to 47′ in 7 to 8 seasons, next *Artocarpus chaplasha* 25′ in 9 years, odd patches of *Michelia oblonga* 22′ in 7 years, *Lagerstrœmia flos reginae* 13′, 15′ and over 20′ in 7, 8 and 9 years respectively and *Phoebe* 10′ only in 8 years. Where *hollock* was the primary species, it formed a close canopy (indicating the necessity for a thinning) holding undergrowth in check, but elsewhere blanks in open areas were fully covered with evergreen undergrowth 10′ to 15′ high, various climbers and shrubs like *Macaranga* that had to be cut down. The few odd original trees left in the area had also to be girdled. *Lagerstrœmia* tried between 1929-31 in the low-lying areas were soon completely covered by prolific growth of *ikra* (*Erianthus ravaneae*), *nal* (*Phragmites karka*) and other grasses and lost sight of.

40. *Jokai taungya*, 1936 (12 acres).—A secondary crop of mixed fuel species resulting from a failed plantation was clear-felled and burnt in March. Stumps of *Lagerstrœmia* (*jarul*) were planted, 6′ by 6′, between early April and mid-June along with brinjal and beans by the *jhumias* who did necessary rains weedings. The average height of plants was 4′ (maximum $5\frac{1}{2}$′) at the end of the first season—the earlier planted stumps were better than the later ones and the *taungya* method as well as planting in patches, instead of strips, appeared a definite improvement. The 1935 *departmental Medla plantations* of the same species offer a comparison. About 23 acres were clear-felled and burnt in January-February and 8′ wide alternate strips were prepared by hoeing. Seed was sown from mid-April till end of May 1935. Weed growth in the inter-strips was vigorous overtopping the plants and continual weeding had to be carried out in the first year and fairly frequently in the second. The smaller plants were only 2′ high, bigger 5′ at the end of the first season, fully stocked and averaged $5\frac{1}{2}$′ (maximum 8′) at the end of the second, when weed growth was very much in check except clumps of grass in places. Here also plants from earlier (April) sown seeds were decidedly better than later ones. The cost (per acre) of formation was Rs. 22-10-0, of weeding Rs. 5-8-0 in the first year and Rs. 2-4-0 in the second, totalling Rs. 30-6-0 at the end of the second season.

1934 *Hollong (Dipt. macrocarpus)* plantation originally under shelter wood. Average height 5′ and over in 3 seasons, condition vigorous (note healthy terminal buds of the season.) (vide para 41.)

15th Jan. 1937 at Jaipur (Lakhimpur.)

1936 *Hollock (Terminalia myriocarpa)* plantation raised by broadcast strip method. Aver. ht. 4′, max. 7′, fully stocked at the end of the 1st season (vide para 42)

17th Jan. 1937 at Jaipur (Lakhimpur.)

Photos by the author.

Calcutta Art Press Delhi

41. *Jaipur reserve (all departmental).*—(*a*) The first plantations started in 1934 when patch sowings of *hollong* (*Dipterocarpus macrocarpus*) were carried out in prepared patches, 1′ to 2½′ diameter by 6″ to 8″ deep, over about 20 acres in blanks in high forest under the diffused shade of shelterwood that was gradually removed. Three weedings were required in the first season, at the end of which the average height of plants was 15″ (max. 21″). Only one acre is now traceable and plants in the few specially looked after patches along the road were quite vigorous with an average height of 6′ at the end of three seasons. With heavy weed growth every year, it proved difficult to manage these widely scattered patches and such irregular sowings were given up in favour of smaller demarcated areas under a more intensive method. In 1935, a fairly open area (about 11 acres) was clear-felled, jungles cleared but not burnt and small patches or *thalis* (2′ by 2′), spaced 8′ to 10′ apart, were worked up by hoeing, and *hollong* seeds sown in March-April at 5 seeds to each patch. *Tephrosia candida* was also sown alongside the patches for the purpose of shading the plants. Weedings were regularly done in the rains, in spite of *Tephrosia* which only partially prevented weed growth in the first year succumbing thereafter to the latter. The average height of *hollong* was 15″ at the end of the first year and 3′ to 4′ at the end of the second. The cost per acre worked out at Rs. 23-9-0 till the end of the second year (Rs. 16-11-0 for formation and Rs. 6-4-0 for two years' weedings).

42. (*b*) The *regular* series of *strip plantations* commenced in 1935 on 15 acres under *Lagerstrœmia* (specially on low-lying areas) and *hollong*, and continued in 1936 on 8 acres of hill slopes under *hollock*. The area was clear-felled in December-January, debris burnt in February and 8′ wide worked up (cleared and hoed) strips, alternating with unworked strips 12′ wide in the first year and 6′ in the second, were run parallel to one another, more or less in the same direction. In the former, *hollong* seeds were dibbled in three rows, 3′ apart, during March-April, *Tephrosia* being sown at the same time along their outer fringes to form a sort of hedge against weeds from adjoining strips; seeds of *Lagerstrœmia* were broadcasted by the end

of May in the 1935 area, and of *hollock* by the end of March in 1936 without *Tephrosia.* Weed growth was prolific in the rains, killing out considerable *Tephrosia* and *Lagerstrœmia* plants and at least three weedings had to be carried out in the first year with almost an equal frequency in the second. *Lagerstrœmia* plants were almost given up for lost; survivals were, however, 3′ high at the end of the first year, *hollong* 1′ and 3½′ at the end of the first and second years respectively. The quick growing *hollock* (1936) was the best and most densely stocked, presenting an appearance of long, continuous, well tended and very fully stocked nursery beds; plants were vigorous, average height 4′ (max. 7′) at the end of the first season. The cost of formation of 1935 *hollong* and *Lagerstrœmia* worked out at Rs. 20-5-0, of tending in the first and second years at Rs. 4-8-0 per annum, totalling Rs. 29-5-0 per acre up to the end of the second year; while for the 1936 *hollock*, formation cost Rs. 15 and tending in the first year Rs. 11-9-0, totalling Rs. 26-9-0 per acre up to the end of the first year. Besides these, patch sowing of *hollong* (with *Tephrosia* around) was done in 1936 on a small scale—patches spaced 8′ by 8′ in the manner already described. Two weedings were carried out, and *Tephrosia* that appeared to have been affording much shade was cut down except only to form a thin semi-circular fencing along the eastern and southern fringes of individual patches (as a protection against sun in the hot weather). The cost was Rs. 2 for formation and Rs. 7-8-0 for tending—total Rs. 9-8-0 per acre for the first year.

43. **Departmental** strip sowing was similarly done at Podumoni in 1935 and 1936, mainly with *hollock*, besides *hollong*, *Cedrela*, *Altingia*, *Lagerstrœmia*, *Artocarpus*, etc. *Hollong* was sown at stakes 6′ apart in the strips and casualties beaten up with direct sowing and transplanting of other species. Three weedings were done in the first rains, and the growth of *hollock* was remarkably quick so as to close up during the second season with only one or two weedings and cleanings. The latter included a mechanical thinning, by which spacing was reduced to 3′ or 4′ for bigger plants and 2′ for smaller ones; marginal rows were not, however, thinned as they were intended to form an effective fence against incoming weeds from either side.

1936 *Hollock taungya* in 6′ strips with sugarcane in the intervening 16′ strips, at the end of the 1st season; *hollock* 3′-4′ high and sugarcane 6′ high (vide para 44)

1935 *Hollock taungya* at the end of the 2nd season when sugarcane was being removed from intervening strips. Average height of *hollock* 10′ (max. 15′) (vide para 44)

26th Jan. 1937 Sola Reserve (Sibsagar.)

Photos by the author.

1935 teak fully stocked. Average height 12′ (max. 15′) in 2 years, raised by stump-planting at 6′x6′ espacement. (vide para 46)
30th Jan, 1937 at Diphu (Nowgong)

1930 *Hollock* plantation, aver. ht. 40′-45′ (max 50′) raised by broadcast strip-sowing. Stems are bending outwards (vide paras 39 & 49), canopy closed and evergreen weeds checked.
23rd Jan. 1937 at Jokai (Lakhimpur)

Photos by the author.

Calcutta Art Press Delhi

The average height of *hollock* was $3\frac{1}{2}'$ in the first season and about 12′ (max. 15′ to 17′) at the end of the second season, when *hollong* too was $4\frac{1}{2}'$ high (max. 6′), *Altingia* 5′ and *Cedrela* $6\frac{1}{2}'$ (max. 10′). Cost of formation was Rs. 16, of three weedings in the first year Rs. 10-8-0 and in the second Rs. 3-8-0, which together came up to Rs. 30 per acre up to the end of the second season.

44. (*ii*) *Sibsagar.*—The *Sola reserve taungya* is the most economic method of plantations originating from the " broadcast strip method " of Sadiya (introduced since 1924). Being surrounded by tea estates on all sides, and not far from the railway line, there is always a ready market for all classes of forest produce. Normally the felled area is cleared by the *jhumias* (usually *Nepalese*) between February and mid-March, and completely burnt by them by the end of March. Collection and carriage of seeds have to be paid for. 6′ wide strips for forest plants are run on, alternating with 16′ wide (sometimes 10′ to 20′ wide in the past) strips for the field crop of mainly sugarcane. The strips are hoed up early in April and sowing done by forest guards towards its latter half. Three weedings are done free by the *jhumias* in the first rains, and with a good crop of sugarcane no weeding is usually required during the second year's rains, at the end of which the *jhumias* remove heir crop and all weedings thereafter have to be paid for. *Hollock,* in particular, is well established by then, requiring no further expensive weedings. During the 10 years 1927-36, some 331 acres of *taungya* plantations have thus been raised, the cost of creation averaging at Rs. 2-9-0 and of subsequent upkeep at Rs. 2-2-0 per acre, which compare remarkably well with costs elsewhere. The principal species has always been *hollock,* others being *Lagerstrœmia, Albizzia lucida* (1932), *Chickrassia* (1929) and *Bischofia* (1927) that were oddly mixed up. But *hollock* has always got the lead over all others, exhibiting the futility of intimately mixing other species with it. The oldest (1927) *hollock* is 50′ high, its progressive growth from different years' plantations appeared to be 3′ in the first year, 10′ (max. 15′) in the second and 30′ to 35′ in the seventh. Thinnings in the past have been very light and cleanings irregular, with the result that the older crop is malformed and unpromising in many places.

45. The *departmental* plantations at Hollongapara also went through two stages, as at Jokai, *viz.* (*a*) *strip plantations in the natural forest in the form of tunnels,* between 1924 and 1930 (245 acres), and (*b*) *regular plantations by wholesale clear-felling* and burning, between 1929 to date (at about 20 acres per annum). In the former, 8′ wide strips were cleared through the forest at intervals of 33′ centre to centre, the strips in turn being filled up by patch sowing and transplanting, at 6′ intervals, of species like *hollong, Amoora* and *Artocarpus.* The oldest (1924) *hollong* was only 20′ to 25′ high at the end of 13 years, and the youngest (1930) 15′ after seven years. These strips were thoroughly cleared last winter at a cost of about Rs. 5 per acre, and the crowns of big trees spreading from adjoining forest belts were causing enough suppression. The cost of these plantations worked out at Rs. 14-13-0 for formation and Rs. 23-1-0 for ten years' upkeep per acre, but it is doubtful if even 50 per cent of the area is adequately stocked and growth of plants has been extremely slow. In the second stage of *regular strip* plantations, annual coupes were first clear-felled and burnt by contractors in return for the timber and fuel removed. Usually 6′ wide strips were run throughout, alternating with intervening strips of different widths in different years—the former set hoed up and broadcasted with seeds of *hollock, jarul* and *Chickrassia.* The 1930 *hollock* is an excellent plantation with an average height of about 45′ in seven years and requiring an immediate C-grade thinning, the 1932 *hollock* about 25′ in five years; the 1931 and 1935 *jarul* were also promising after multiple shoots had been thinned out. The cost of six years' plantations (1929-34) worked out at Rs. 27-3-0 per acre for creation and Rs. 29-1-0 for upkeep for five years.

46. (*iii*) *Nowgong.*—Experimental *shelter-wood* plantations (*departmental* and *taungya*) have been carried out at Diphu since 1929. The procedure is that they start with a shelter-wood of high forest that is gradually removed, as required for the benefit of growing plants, till the residual overwood is finally felled or girdled. The object was to reduce the cost of clear-felling unmarketable produce or to defer it till there was a demand for the same and to minimise weeding operations. Sowing was on cleared strips spaced wide apart;

bonsum (*Phœbe*) appeared to do well in the open, while its growth under heavy shelter-wood was slow and very irregular. The oldest (1930) *bonsum* was 12′ to 15′ high in seven years and *Amoora* (1929) 20′ to 25′ high in eight years in the open. There was no economy in the cost of tending operations and the *taungya* plantations here were not much of a success, while departmental teak plantations of 1935 and 1936, where teak was stump-planted, 6′ by 6′ apart, were well stocked and quite promising, about 4′ high in the first year (max. 6′) and 12′ (max. 15′) in the second year.

47. *Experiments on artificial regeneration.*—Some experiments were carried out by Mr. Rowbotham between 1927-29 in Jokai and Sola reserves. The 1927 *hollong* at Jokai has attained a height of 50′ to 60′ (max. 70′) and an average girth of 1′·6″ in 10 years, which is very remarkable. *Artocarpus* raised by the strip (8′ wide) method of sowing, originally with *Tephrosia* and *Cajanus indicus*, is excellently stocked with an average height of 45′ to 50′ in nine years requiring a heavy thinning. The cost of its formation was very high, Rs. 84-15-0 per acre in the first year and for tending Rs. 16-6-0 and Rs. 17-8-0 in the second and third years respectively. In the Sola reserve, small plantations were raised in 1927 and 1928 by (incomplete) clear-felling, burning and transplanting at 4′ by 4′, *Taluma phellocarpa*, *Cinnamomum* and *Altingia* with balls of earth and direct sowing (or transplanting natural seedlings) of *Artocarpus* with *Tephrosia* and *Cajanus* put out the following years. *Artocarpus* was a complete failure on account of wild elephants, but the others, especially *Talauma*, succeeded well, now well stocked with an average height of 40′ to 50′ needing an immediate thinning. The cost for eight years amounted to Rs. 89-7-0 per acre for the 1927 area, and for seven years to Rs. 45-3-0 for the 1928 area.

48. The small 1935 experimental plantation of *hollong* in the rest house compound at Jaipur, where seeds were sown in four rows on 6′ wide prepared strips with *Tephrosia* on either edges (that was lightly thinned during the second rains) is an excellent show with an average height of 7′ in two years. These *hollong* plants growing under ideal conditions shew how quickly they could be made to grow

in regularly tended plantations. The initial layout, the use of *Tephrosia* and its subsequent treatment, have a striking resemblance to the Bengal method of raising *gurjan*. The 1935-36 nursery and garden experiments of raising different species of *Magnoliaceae, Phœbe, Cinnamomum* and *Amoora*, with or without *Tephrosia* are quite interesting, particularly the 1936 cold weather transplanting of *Phœbe* and of 16 months old bigger plants of *Mangletia insignis* (transplanted with balls of earth when 4½′ or 5′ high), acting on the local tea garden practice of post-rains transplanting. Their behaviour in the first hot weather after transplanting must be a matter of special interest. Nurseries are being maintained at different centres, and germination tests as well as comparative growth of plants raised from direct sowing, entire transplanting and stump-planting of indigenous species (with different origins, for inheritance of characters) are being studied in silvicultural gardens since 1935.

49. *Retrospect.*—Conditions of soil and climate with consequent distribution of moisture are very favourable from the regeneration point of view, and with adequate care at the initial stage most of the local species could be raised successfully and with great rapidity of growth. Failures in the past may be ascribed to (*i*) comparative neglect of evergreen forests in relation to sal; (*ii*) want of regular working plans or plantation schemes; (*iii*) extreme difficulty in obtaining labour; (*iv*) largeness of areas at the experimental stage; (*v*) want of funds and staff when they were most needed; and (*vi*) lack of sufficient local information on the details of nursery and plantation technique, etc. There has not been any wholetime Silviculturist for the last seven years and investigations have still to be in their preliminary stages. In the zeal for creating new plantations, older plantations had eventually to suffer for want of timely cleanings and thinnings. Fortunately, it has now been standardised that existing plantations must have precedence over the establishment of new ones when funds and labour are limited. The hill tribes have ample areas in unclassed forests for *jhuming* and there is not much " land hunger " to attract them or others to the reserves under any stricter terms. The tea estates permanently maintain gangs of imported labour on

more attractive conditions than the Forest Department can offer, and it is the rejected lot of the former that is available to the latter. The method of sowing has undergone considerable modifications from the *tunnel or avenue* method to clear-felling and *broadcast strip sowing,* and on account of its easy seed collection and quick growth, *hollock* is the only species whose plantations have attained some measure of success. Recent working plans for SADIYA and LAKHIMPUR plains and the plantation scheme for SYLHET offer useful guidance for future. The method of strip-sowing *hollock*, advocated on the ground of economy in weeding, and prevention of side branches has not realised its object. Apart from frequent weedings required in the first two years, early congestion needs prompt spacing out, and straight stems are difficult to obtain, the majority being bent sideways and retaining the same form long afterwards; the central set of plants do not show the desired results but those along the edges look more promising. Besides, the method is responsible for an enormous waste of seeds and seedlings, and the cost of initial weedings, on which ground the strip method is sought to be justified, is not reduced to any extent.

50. *Proposals for future.*—The writer suggests that the strip method may advantageously be improved upon or supplemented by the patch method of sowing (spaced 4′ by 4′) tried out properly in so far as quick growing *hollock* and *jarul* are concerned. The proper use of *Tephrosia* also needs further study and the local tea estates use it extensively. Its improper use in places (even outside Assam) has misled many to treat it at times with real suspicion. A reference is invited to the latest (1937) edition of "Nursery and Plantation Notes for Bengal" which deal with a number of species common to both the provinces. Detailed information is given there on the technique of *taungya* and *departmental* plantations including forest nurseries. The treatise is the result of various experiments extending over two decades and is likely to be helpful in Assam with local improvements as circumstances require. It is suggested that the plantation programme should include wholesale clear-felling (November-January), adequate drying of the slash (February) and thorough burning in two stages to be completed by the first week of

March. The area is then to be prepared by staking (spaced 6′ by 6′, or 4′ by 4′) for *patch sowing* or by light-hoeing in 2′ to 3′ wide strips, 6′ to 8′ apart centre to centre for linear *strip-sowing*, by the end of March. With moderate rainfall in April early sowing or planting is justified, and all sowing or stump-planting should be completed in April. The species tried so far can be classified into (*a*) *fast-growing*, *i.e.*, those attaining 6′ and above in two years and 10′ and above in three years, *e.g.*, *hollock*, teak, *gamari*, *jarul*, etc., and (*b*) *slow-growing*, *i.e.* those growing less quickly than the above, *e.g.*, *hollong*, *gurjan*, *sal*, etc. It is suggested that species under (*a*) should be put out by direct sowing or stump-planting, as the case may be, in patches by a little soil-wounding (with a *dao* and not by the hoe), while for those under (*b*) *linear strip-sowing* of seeds in two to three rows (and not broadcasting) is the method recommended. The interspaces must hold some field crop like paddy (dry cultivation), cotton, brinjal, beans, etc. (or sugarcane, only in the case of linear strip-sowing and not for patch-sowing) as in the case of *taungya*, or a nurse crop like *Tephrosia* in the case of *departmental* planting, to be introduced almost simultaneously with the forest crop. Very fast-growing *hollock* or teak should be tried without *Tephrosia*, but with more intensive weeding in the first rains and possibly with close spacing. Rains weeding should always be intensive in the first two years (twice or thrice as required). *Tephrosia* must be trimmed, lopped, thinned or even cut back so that it can never interfere with the leaders of the growing plants in the rains. The fast-growing species are likely to establish themselves at the end of the second rains, and the slow-growing at the end of the third or fourth. No weeding (or inspection cleanings) should be undertaken after October till the early showers of the next rains, but creepers actually interfering may be pulled out any time. The first thinnings would be required, for quick growing species, usually in their fourth or fifth year and such thinnings must always be at least C-grade. No underplanting nor any intimate mixture in the form of matrix is recommended between two or more species that are all light-demanders as well as fast-growers. Even alternate lines of fast-growing species

with the slow-growing ones close up far too quickly and cost a lot in frequent thinnings to give enough light to the latter. *Gurjan*, *hollong* or sal may be sown in strips of five to seven lines, 6′ apart alternating with three to five similar lines of *Gmelina* spaced 6′ apart in its lines also. This is indicated elsewhere to be better than the quincunx method with *gurjan* in the centre and *Gmelina* at four corners.

The above suggestions may be helpful in initiating proper experiments to get truly comparative results to assess their relative economic use and consequent adoption as standard methods.

(*Concluded.*)

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THE LAND OF "HANUMANS"—ITS FORESTS AND PEOPLE

BY M. S. BALASUBRAMANYAM, E.A.C. FORESTS.

Abstract.—The article in the main is a short description of the Andamans and its forests "in a lighter vein." The activities of the Forest Department and the pleasures and pains that the local Forest Officer endures in the course of his duties are also described.

The "monkey-god" *Hanuman* requires no introduction to Indian readers. The very mention of the word is enough to rouse a feeling of reverence in the minds of all Hindus throughout the length and breadth of India. The Malay equivalent of the word is Handuman, and it is but a step to change the word Handuman to the modern Andaman. So we see how the derivation of the name of this sinister group of Islands is dear to Hindu mythology.

In passing, this reminds me of the name of one of the bridges in Madras. It is said, and I say this subject to correction, that the bridge in question was named "Hamilton Bridge" some decades ago. The *Tamilian* with his innate knack of softening the aspirates called it the "Amiltan Bridge." The change from "Amiltan" to "Ambatan" is easy and imperceptible; and "Ambatan" means in the vernacular a barber. So the story goes that the bridge is now called "Barber's bridge" and this is a tram terminus.

To come back to our main article, the Andaman Islands were known to the Malays from early times as the land of the "monkey people." Please note the word "people." It is not the land of monkeys. There are no monkies in the Andamans, though in the sister Islands, the Great Nicobars, they are to be found in plenty. To the South Indians of medieval times the Andamans were known as the abode of the "Rakshasas" and "cannibals"; and this idea seems to have persisted even till late in the last century. So far about the ancient history of the Islands.

To the man in the street in India, Andamans means nothing; but if you say "*Kalapani*" it is, probably, more intelligible. To the more educated and the enthusiastic reader of the newspapers the recent appellation of "Prisoner's Paradise" would convey some meaning. Our knowledge of geography must be very poor indeed.

Fig. I- That is Chatham Island, the Headquarters of Forestry in the Andaman. Please see the bridge connecting it with the mainland.

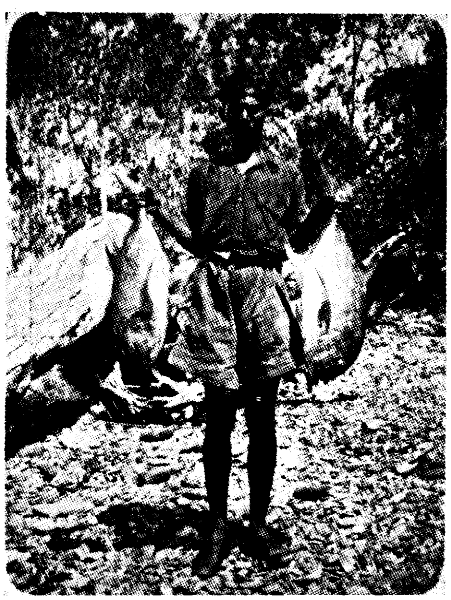

Fig. II- "Give us this day our daily fish" Two *kokaris* weighing about 24 lbs, caught while on the way to camp.

Fig. III- "Look out! don't sink in the loose mud." A mangrove swamp with *Rhizophoras* behind.

Photos by M.S. Balasubramanyam.

Fig. IV- A mangrove forest with the stilted *Rhizophora* in front and the *Bruguiera* behind, in plantation style.

Fig. V- "Extraction Camp." Row of huts housing labour.

Fig. VI- The commodious hut of the "Range officer" right on the bank of a creek.

Photos by M.S. Balasubramanyam

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Thanks to our imagination; it has not yet extended up to the "Artica" and the Antartica, but these Islands have been conveniently placed anywhere between the shores of Africa and New Zealand. This might seem an exaggeration; nevertheless it is true, for a certain educated gentleman actually asked me whether Port Blair was not somewhere near Durban. The Andamans! It must be somewhere at the back of beyond, and to go to the Andamans means sailing to an unknown, "never-to-return" place. To give the readers some idea of the position of these Islands it must at once be said that they lie in the Bay of Bengal, and Port Blair, the Headquarters, is about 780 miles from Calcutta and about 740 miles, nearly east, of Madras. It is near and yet so far.

Speaking geologically it may be said that the Andaman Islands are the summits of a submarine range of mountains running continuous from Cape Negrais, in Burma, to Achin Head, in Sumatra. If we can imagine a huge Gulliver, sufficiently tall to take a long stride he can hop over from Cape Negrais to the Andamans in three strides and then pass on to Achin Head without wetting his feet. From Cape Negrais his first step would be on Preparis Island, the second one on Cocos and the third on the Andamans. It is even said that "Hindu legends notice this remarkable range, ascribing it to Rama, who attempted here first to bridge the sea, an enterprise afterwards transferred to the South of India" at the point called Adam's Bridge.

To come to the Andamans, you catch the "Maharaja," which is, by the way, a 2,000-ton steamer, at Calcutta or Madras. You can take the ship even at Rangoon, but that is, perhaps, too round about. If you are not unlucky to be caught in a cyclone, you sight the Andamans on the morning of the fourth day. Strictly speaking it should not take you more than 72 hours for the journey.

The panorama that meets the eye on sighting the Islands is simply wonderful. A number of Islands, big and small, dotted all over the sea (the Andaman Group is said to contain 204 Islands); the profusion of hills of varying heights rising all in confusion; the dark green vegetation covering the hills from the sea coast to the

summit, the beautiful silvery white sandy beaches—all these afford a magnificent spectacle. You cannot but be struck by the beauty of it. It is not, as is commonly believed, a spit of land surrounded by battlements in which convicts roam about like so many wild beasts in a den. The Islands comprise a land area of 2,500 square miles, that is, about $1\frac{3}{4}$ times that of Cochin State.

The biggest Island of the Archipelago is about 400 square miles and the smallest just a few acres in extent. The land rises up and falls rapidly and so encloses only narrow valleys. The land seems to be in a hurry to imitate all the natural features of a large continent and this accounts for the absence of any wide water-courses to which the dignified names of rivers could be applied. The highest mountain iscalled the Saddle Hill and the highest peak the Saddle Peak (2,400′). There are a number of other peaks ranging down to 1,000′.

The months of January to April would, probably, be the best months for a voyage out here. The other months would be rather roughish and the months of June to September, probably the worst. Blinding rain followed by heavy squalls is the state of the weather during the last mentioned four months when the south-west monsoon is in full swing. It never rains but it pours and a fall of six inches a day is very common. 100 to 150 inches of rainfall is the annual average. Plenty of rain and heat !—ideal conditions for a tropical rain forest.

Being surrounded by the sea you get the benefit of the fresh cool sea breeze at all times of the day and this to a great extent minimises the heat of the day. The temperature throughout the year is mild and does not go above 95 deg. in the hottest summer or below 70 deg. in the coldest winter. " The temperature must, therefore, be described as normal for tropical Islands of similar latitudes " (Sir R. Temple).

The " Maharaja " has reached Port Blair. It passes between the mainland of South Andaman Island and another small Island. That is Ross Island, the seat of the Local Government ; and that is Aberdeen ; that is Haddo, Chatam Island and so on. The Forest Officer with an eye for the beautiful in Nature has no interest in the

humdrum buildings, the motor cars, buses, telegraph, telephones, etc. Yes! the Harbour! What a beautiful land-locked harbour! You look wistfully at the well-wooded hills surrounding the harbour. A magnificent harbour and a magnificent view! Andamans are provided with a number of such beautiful harbours. The sylvan surroundings are charming and the lovely beaches invite you to bathe.

The ship has anchored; a ferry boat draws alongside the gangway. The ship is full of convicts. You find people from all parts of India; from the hefty Pathan of the N.W.F.P. to the Moplah of Malabar—all the Provinces of India and Burma are represented. It may be mentioned, by the way, that there are no hotels in the Andamans. Perhaps this does not matter as you have some obliging friends to put you up during your stay. You get off, therefore, to your lodgings. After lunch we can take a taxi down to Chatam Island. Don't stare! Yes. Chatam is an Island. The shallow inlet of the sea separating it from the mainland has been bridged and you can taxi right into the island. On this island is the Headquarters of Forestry in the Andamans.

On this island there is a wharf for berthing the "Maharaja" and other fairly large sea-going vessels; there is a smaller "ramp" for unloading logs from the Forest Department boats; and the most important of all these is a big Forest Department sawmill. You get the first acquaintance of names like *padauk*, *gurjan*, silver grey, etc.; and beautiful timbers some of them. It is most interesting to watch the mill working. The whilom giant of the forest is laid low, and as the log goes moaning its way through the saw you feel at once a sense of pity and admiration. The logs are cut up into squares and scantlings and they are stacked up in their respective places. Let us reserve our inspection of the mill when we return from the forest. The "Surmai" is leaving for the camp that night, and so you must get back home and make preparations for going out. While packing up your kit don't forget to take your gun and fishing tackle.

The first thing that strikes you in the camp is that there are no roads or railways in the forest. The sea is your highway; and the motor boat or a jolly boat is your only means of locomotion.

After an early breakfast we leave for a lumber camp or an "extraction camp" as it is locally called. The motor boat is ready and we may have to take a dinghy in tow. A couple of sandwiches and a thermos of coffee or tea is all that would be necessary. But do not forget the fishing tackle, the gun and your bathing kit. It will be possible to combine work with pleasure.

The motor boat now "chug-chugs" along to the camp and if the sea is calm and you do not get sea-sick on the way we enjoy the trip.

"Khir -r-r-r-r---"

"Hang on to the line. A fish has been hooked."

Heavens! What a pull! The rod is bent nearly double. There is a regular fight for about fifteen minutes, after which the fish is heaved in-board. A fine *kokari* weighing 20 lbs. Jove! What a pull! If you are lucky it is possible to land about half a dozen good fishes in about half an hour.

The camp is now reached. You now leave the motor boat and get into the dinghy. You have to go through a narrow creek going through the mangrove. The real forest interest now begins. At high water the mangrove forest presents a very interesting sight: all the trees seem to grow out of the sea. The problem of reaching the camp becomes very difficult at low water. The dinghy gets stranded and you will have to get out of the boat and step into the loose mud. The *Rhizophoras* line all the water's edges and their stilted roots are a source of great annoyance. They block your progress and you cannot proceed; but look out! don't sink in the loose mud! If you are careless you sink sometimes waist deep. The Jarawas and *must* elephants—for Heaven's sake do not think of them now! Let us get out of the mud first. Ah! the sandflies and the mosquitoes!

After a certain amount of toiling and sweating, you reach firmer soil; and walking is now easy except for an occasional stumbling

against little humps called "knees." These are the "*pneumatophores*" or the aerating roots of the tall mangroves that you now meet with. This is the forest of *Bruguieras*. These tall straight mangroves, with clean boles up to 80′, look like a regular well-tended plantation; and they get the protection afforded by the *Rhizophoras* against the undermining action of water and wind. As we go further in we encounter mangroves like *Avicennia officinalis, Ceriops, Carapas, Sonneratias* and other species. As we come closer to dry land the tall trees give way to thorny bushes of *Phoenix paludosa, Licualas, Nipa fruticans,* etc.

Leaving the mangroves we reach dry land and walk up to the camp. The camp is built on a slightly sloping ground, so that there may be good drainage. A species of mosquito (*Anopheles ludlowii*) is said to breed in the small pools of salt water left by the high tide and so we are advised to build camps at least half a mile away from the nearest mangrove swamp. This is not always possible, for we are so much surrounded by salt water creeks that if we go half a mile to one side, the creek on the other side is less than half a mile away. In a new camp this, however, does not seem to matter very much, as people living near the mangrove are as much happy and healthy as those far removed. In fact owing to want of roads or even footpaths in the forest, the men, for the sake of convenience, try to keep as near the creek as possible.

In a small clearing in the middle of the forest you find the camp. There are two rows of huts facing each other; and these house the labour. Overlooking these there is a more commodious one, housing the Officer-in-charge of the camp, called by the courtesy title of the "Range Officer." The huts are typically Burmese in construction, the floor being raised 4′ to 5′. The walls and floor are made of well plaited bamboo mats and the roof thatched with cane leaves. In spite of the fact that the huts look as if they have been built on stilts, they are quite firm and comfortable, and some of them, especially those of the Burmans, are really artistic.

"*Sahib!*" you are accosted. *Ek Nális* (complaint).

You turn round and ask, "Well?"

"I do not want to work in this camp. I do not like the Range Officer."

"Why? You must obey the Range Officer. You must work here."

"No *Sab*. You can send me back to jail. My number is ... etc. etc."

That is the refractory convict whom we often meet with in the camps. He is more happy in jail than at work. We have to send him back to prevent further trouble. A majority of convicts, however, make good workmen and work willingly.

If you are early in the camp you will see the elephants being brought in for their morning bath. They are bathed and are examined for signs of any sickness. They are then harnessed to their dragging gear and marched off to work. The dragging gear consists of the girth strap (*galabund*), the *mota rasi*, *gaddi*, drag chains, etc. The *gaddi* is fixed on the saddle, and the *mota rasi* slung over it. The *galabund* is taken round the "shoulder" of the elephant and is held in position by passing its ends through the *mota rasi*. To the two loops at the end of the *galabund*, the two drag chains (one long and the other short) are attached. The elephant is now ready. It may be mentioned here that the dragging gear, such as *galabund* and *mota rasi*, are made out of the fibre of *Sterculia villosa*.

Let us follow the elephants to work and as we go we can take a look at the forests.

The elephant, if it is dragging *padauk* (*Pterocarpus dalbergioides*) is taken to the deciduous type of forest. This type contains all the important and valuable timber trees of the Andaman forests. There is the *padauk*, *Canarium euphyllum* (*white dhup*), *Sterculia companulata* (*papita*), *Terminalia bialata* and *T. manni* and *T. procera*, *Lagerstremia hypoleuca*, *Tetrameles nudiflora* and so on. The undergrowth in these forests is not very heavy, but is full of thorny bushes and climbers. The *badmash kanta* (*Plecospermum andamanicum*) is a real *badmash*; and if a thorn gets into the foot

Fig. VII- "Dragging". Elephant in full dragging gear with a log behind. "Galabund" in full view.

Fig. VIII- "The fellers have to build a machan" A buttressed *padauk* being felled.

Photos by M.S. Balasubramanyam.

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Fig. IX- "Rafting depot."
"Aung" Aung". Elephant raft.
Tall *Bruguieras* behind.

Fig. X- "Rafting depot."
"Hudi." Elephant pushing the log into
the water.

Photos by M.S. Balasubramanyam.

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it takes at least two months to heal. Now and then we come across a good patch of bamboos. The forest on the whole is dry and waterless, and the soil is coarse and rubbly. In the dry weather these fodderless, leafless, and waterless forests demand a heavy toll on the health of elephants, and people working here have to carry with them bottles of water to quench their thirst. A walk through this type of forest is not very taxing as there are no steep slopes to negotiate. The ground is just undulating and never rises to more than about 300′.

If the elephant is put on to dragging *gurjan*, we go to a cooler type of forest. The soil here is more moist and clayey, and all the trees are full of leaves and have the healthy colour of luxuriance. This type is the evergreen forest of the Andamans, and is found clothing all the higher and steeper hills. A long walk through this forest is rather strenuous.

Are you thirsty ? If so, you can immediately cut the thick cane (*Calamus andamanicus*) and have a good drink of water from a cut end. Do not stray away from the beaten track in these forests. The undergrowth is very heavy and it would be a Herculean task to cut your way through. The whip-like appendages of cane leaves have recurved thorns and if they get you by the ear or any part of the body there is trouble. Tall, smooth, white stemmed *gurjans* (*Dipterocarps*), *Artocarpus chaplasha*, *Calophyllum spectabili*, *Planchonia andamanica*, *Endospermum malaccense*, *Parishia insignis*, *Sideroxylon longipetiolatum* are some of the valuable species that the Forest Department takes out from these forests. The atmosphere here is dark, suggestive of a dense canopy, and you feel at once a distinct change.

As we walk through we may pass along the banks of a winding stream. On these alluvial valleys which have an excellent drainage, we find a magnificent mixed type of forest called the semi-evergreen or the low evergreen type. In this type we find, on the one hand, *padauk*, *white dhup* and most of the other species of the deciduous forest, and on the other the *gurjans*, *Artocarpus* and other species of the evergreen. *Padauk* forms but a small percentage of the stand, but what there is, is well and nicely grown. While the trees have a magnificent growth, the undergrowth is staggering. This is the best type of forest to work for ; while it does not have the

disadvantages of a pure evergreen or a pure deciduous type, it has the advantage of possessing all the important timbers that we want in one compact block. There is a good water supply, and plenty of bamboo and other fodder. Elephants keep healthy and they love to split and eat the *bania* (*Pisonia excelsa*) that grows plentifully all along the banks of the stream. Sometimes, especially near the creeks, these alluvial flats are very extensive. Water more or less stagnates and drainage is slow. These are called *bania kharis*. There are pure patches of *bania* and *Anthocephalus cadamba* in these *bania kharis*.

The elephant is probably ready to take a log. We shall go to see it. About a foot or two from the end of the log a groove is cut so as to take the drag chain, and the portion between the groove and the end of the log is sloped down so as to take away the sharp end. This is called " *napha* cutting " or " snouting," and this prevents the log from catching the mud, stones and other things while dragging.

" *Aung*; " " *Agai* ! " You hear such shouts. It is the *mahout* manipulating the log to tie the drag chain. The longer chain is first taken round the groove in the log and fastened. The shorter chain is then hooked on. The log is now ready to be dragged.

In walking through the forest you will notice that most of the trees have buttresses. Some of the buttresses are so large that they look like high walls. They are a source of annoyance to the fellers, but at the same time a source of profit to the Forest Department. The buttresses yield sometimes excellent pieces of timber, and one such piece, given to Lord Kitchener, measured 12′ 9″ by 7′.

The fellers have to build a *machan* (scaffolding), sometimes 10′ to 12′ high, to get above the buttress. It is interesting to watch a tree being felled. A small notch is made with the axe on the side in which the tree is to be felled, and on the opposite side the saw is applied. As the saw cut proceeds wedges are driven in the cut and the fall is directed. In about 15 to 20 minutes the forest " giant " crashes down.

As we return to the boat we can watch the elephant doing rafting work. The elephant *aung's* and pushes the logs into the water. If the log floats there is no trouble. But if it sinks it has to be tied with floaters. The logs are tied with split canes to two stout " ballies "

placed crosswise across the logs at about 4′ to 5′ from either end. Four to five logs form one raft.

We probably go to one of the sandy beaches to have a dip in the sea. As we go we see a new type of forest just behind the beach. This is the littoral type. The country is flat and not much higher than the sea level, but it is full of sharp limestones and coral. The only trees of importance here are *Mimusops littoralis* (Andaman bullet wood) and *Calophyllum inophyllum*. There is *Erythrina indica, Thespesia populnea, Gyrocarpus americanus, Terminalia catappa* and other species but they are not of any importance. The beaches are covered with the goat's-foot creeper with their nice companulate flowers.

You remove your clothes to change into bathing costumes. Lo! what is all this blood coming out. The leeches have been after you. If it is the dry weather you find ticks all over your body. Pick them up as fast as you can before they get hold of you, and rush into the sea. The sea water is said to drive away the ticks and cure the bites. I do not think there is any truth in this.

In all our operations the aborigines, excepting the Jarawa, take no interest whatsoever. The Jarawa unfortunately takes a very lively interest in all our tools and men.

Of these troublesome Andamanese and other interesting matters I shall refer to in my further articles.

ORISSA AND CHHATTISGARH STATES' FOREST CONFERENCE

A conference of thirty-five forest officers representing thirty states and two important *zamindaris* of the Orissa and Chhattisgarh Agencies was held at Sambalpur on the 27th, 28th and 29th September. Papers were read on several items of general and special interest, amongst which the following were the most important: *The Management of Class B Reserves in the interest of the local cess-paying tenants; The Need for improving Grazing Facilities and suggestions for the regulation and control of grazing in reserved forests; Shifting Cultivation and some proposals for reducing the evil; Some Aspects of Lac Cultivation under present-day conditions.*

Much interest centred on the question of shifting cultivation, which still exists in a number of states; and several proposals were made which it is hoped will lead to the gradual extinction of the

practice. Its immediate abolition presents numerous difficulties and it is admitted that, however desirable it may be to stamp out shifting cultivation, it is necessary to proceed cautiously. Propaganda by the forest staff and other departments; the gradual enhancement of the rents charged for *jhuming*; the granting of assistance to those willing to adopt permanent cultivation; the formation of small reserves in areas where the practice is prevalent; the prohibition of *jhuming* on steep slopes and along the banks of water-courses; and the provision of occupations to enable the hill tribes to earn a living, were all put forward as possible means of reducing the evil. And if the resolution drafted by the conference receives the support of the Darbars, it is felt that at last some serious steps are being taken to solve this serious problem. The active help of the Rulers in this matter is essential and is earnestly solicited. The Province of Orissa looks to the states to do something to minimise the intensity of its floods, or at any rate to prevent a worsening of the situation.

The management of Class B reserves has received considerable attention in three or four Orissa states during the past ten years or so, and the same principles are being gradually introduced throughout the Agency where circumstances render it necessary or desirable. The need for maintaining a regular source of supply of small timber and fuel for the local population is fully recognised by most states; and forests are being set aside for this purpose, apart from those which are managed for direct profit. Papers explaining the methods followed in the management of such forests in the states of Keonjhar and Dhenkanal were read so that others might profit by their experience.

Continued low prices and steadily diminishing returns from lac constitute a serious problem in several states, and it is feared that the industry may even die out if steps are not taken to keep it alive. Improved systems of management and better methods of marketing were proposed. The co-operative system of Bonai State commended itself very strongly to the conference, but it was recognised that it was not of universal application. It was, however, the general opinion that the root of the problem lay in paying the highest possible economic rates to the growers in order to keep the industry alive and to tide it over the present period of depression. The conference emphasized the need for control of prices paid by contractors and states to tenants employed in the industry.

Other papers read and discussed were : *Teak Plantation Technique in Bastar States ; The Reclamation of sand-inundated areas by means of Sissu Plantations :* and *the Problem of inter-state Fire Protection.*

STANDARDISATION OF TREATED WOOD POLE SIZES FOR OVERHEAD ELECTRICAL TRANSMISSION SUPPORTS

By S. Kamesam, M.I.E. (Ind.),

Timber Development Officer, Forest Research Institute, Dehra Dun.

The specifications for treated wooden poles for overhead electric supports deal with the raw products of nature and not with factory-fabricated articles. Whether poles are used for electrical transmission, distribution, telegraph or telephone purposes, the pole acts as a cantilever. It has been, for several years, an object of the supplier and the buyer to invent a clear language for the supply and purchase of poles—in other words, to prepare a pole dimension table for specifying a range of pole sizes that are sufficiently comprehensive to include all conditions of load, and, if possible, irrespective of the species.

It has been usual to simplify pole specifications by limiting the size of the ground line dimensions. If the taper in poles of the same species or even of different species is assumed to be the same, it is enough to specify the top size of poles only. Two general classes of dimension tables have come into vogue, namely " class " tables in which the minimum top and bottom sizes are specified, and " top dimension " tables in which the pole classification is based solely on top dimensions. Were it not for the fact that different poles of the same species are from trees that grow with different tapers, the latter method would have been very satisfactory.

As far as actual practice goes, some of the largest consumers of poles in the West have, for many years, purchased poles on the basis of " class " tables where one is able to control the ground line size and also the top size of poles.

STANDARD DIMENSIONS OF TREATED WOOD POLES.

For ov rhea l electrical dis'ribution (including telegraphs and telephones).

Class.		1			2			3			4			5			6			7		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Min. Top Circ. (Inches).		22	24	27	20	22	25	19	20	23	17	18	21	16	17	19	14	15	17	12	13	15
Over-all length in feet.	Height above ground level.	MINIMUM CIRCUMFERENCE AT SIX FEET FROM BUTT (Inches).																				
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
16	12½													18	19	22	16	17	20	15	16	18
18	14½							22	24	27	20	22	25	19	20	23	17	18	21	16	17	19
20	16	26	28	32	25	27	30	23	25	28	21	23	26	19	21	24	18	19	22	17	18	20
22	18	28	30	33	26	28	31	24	26	29	22	24	27	20	22	25	19	21	23	17	19	21
25	20	29	31	35	27	29	33	25	27	30	23	25	28	21	23	26	20	22	24	18	20	22
30	24½	31	34	38	29	31	35	27	29	33	25	27	30	23	25	28	21	23	26	20	22	24
35	29	33	36	40	31	33	38	29	31	35	26	28	32	25	27	30	23	25	28	21	23	26
40	34	34	37	42	33	36	40	30	32	37	28	30	34	26	28	32	24	26	29	22	24	27
45	38½	36	39	44	34	37	42	32	34	39	30	32	36	27	29	33	25	27	31	24	26	29
50	43	38	41	46	35	38	43	33	36	40	31	33	38	29	31	35	26	28	32	25	27	30
55	47½	39	43	48	37	40	45	34	37	42	32	35	39	29	31	36	28	30	34	..		
60	53	40	44	50	38	41	46	35	38	43	33	36	40	30	32	37	29	31	35	..	.	.
65	56½	42	45	51	39	42	48	37	40	45	34	37	42	32	34	39	..	..	..		..	.
70	61	43	47	53	40	43	49	38	41	46	35	38	43	33	36	40	..	..	..	.	..	.

Class.	8			9			10		
		B	C	A	B	C	A	B	C
Min. Top Circ. (Inches).	15	17	18	15	16	18	8	9	10
Minimum circumference at six feet from butt	No butt requirement			No butt requirement.			No butt requirement.		

A class species example—sal.
B class species example—teak.
C class species example—chir.

Breaking load in lbs.

Class 1	.. 4,500	Class 4	.. 2,400
Class 2	.. 3,700	Class 5	.. 1,900
Class 3	.. 3,000	Class 6	.. 1,500
Class 7	.. 1,200		

N.B.—Classes 7, 4 and 2 correspond in safe strength to Hamilton series A B, etc., B C, etc., and C D, etc., respectively.

Typical A class timbers.

Yon (*Anogeissus acuminata*).
Burma lance wood (*Homalium tomentosum*).
Mesua (*Mesua ferrea*).
Ballagi (*Poeciloneuron indicum*).
Sal (*Shorea robusta*).

Typical B class timbers.

Axlewood, dhauri or bakli (*Anogeissus latifolia*).
Poon (*Calophyllum* species).
Sundri (*Heritiera minor*).
Benteak (*Lagerstroemia lanceolata*).
Teak (*Tectona grandis*).
Kindal (*Terminalia paniculata*).
Laurel or asna (*Terminalia tomentosa*).
Irul (*Xylia xylocarpa*).

Typical C class timbers.

Chir pine (*Pinus longifolia*).
Deodar (*Cedrus deodara*).

A new system of standardisation of pole sizes was developed about eight years ago and actual practical experience has demonstrated the soundness of this system. The table of Indian timber pole sizes, given on the opposite page, has been prepared by the writer based on the new pole standardisation system.

The main features of the standard table are as follows :

1. The pole classification table is based on standard ultimate fibre stresses (based on tests on small size specimens) for the species selected.
2. The table specifies dimensions in terms of *minimum* girth in inches at a point 6 feet from the butt (except where no butt dimensions are specified) and *minimum* girth in inches at the top. The latter is necessary for facilitating the standardization of pole fittings and for ensuring a certain minimum degree of stiffness of poles.
3. All poles of the same class and length have approximately equal moments of resistance at the ground line.
4. All poles of the same class have the same approximate ultimate breaking load, assuming that the load in each case is applied at a point 2 feet from the top end, and that the pole fractures at ground line.
5. The smallest sized class for which butt measurements are specified have a breaking load under the conditions specified in principle 4, of approximately 1,200 lbs.
6. Poles of the largest size class for which butt measurements are specified have a breaking load under the conditions stated in principle 4, of approximately 4,500 lbs.
7. The pole classification tables provide for seven classes, specifying the circumference at 6 feet from butt ends, whose respective breaking loads shall be in increasing order from 1,200 lbs. for class 7 to 4,500 lbs. for class 1 ; it may be noted that the difference in strength between class 6 and class 7 poles is 300 lbs., that between class 5 and 6 400 lbs., that between the two next classes 500 lbs., and so on.

The following shows the breaking loads corresponding to the seven classes :

Class		*Breaking load pounds.*
1	..	4,500
2	..	3,700
3	..	3,000
4	..	2,400
5	..	1,900
6	..	1,500
7	..	1,200

Besides these seven classes, the table contains three other classes (classes 8, 9 and 10) with only the top circumferences specified. These may be employed for special purposes.

A little explanation of the features, quoted above, may be necessary for the average engineer, unacquainted with timber technicalities, to comprehend more fully their significance.

The first and second features are based on the accepted practice of the principal wood-pole-using corporations abroad, in which ultimate fracture of the pole is assumed to be at ground level so that the ground line strength, which errs on the safe side in every case (as the section of maximum stress is usually a few feet above the ground level), is employed as a direct basis for pole specifications and pole design.

The average pole (between 25 and 50 feet long) for installation in ordinary soils may be assumed to have the ground line point above 6 feet from the butt-end so that for simplification of labour in producing, stocking and inspection of poles, specifying the dimension at a fixed distance from the butt-end, irrespective of the length of poles, is of decided advantage. Again, the section which is 6 feet from the butt-end is so close to the actual ground line section for any of the usual lengths of poles that any variation in taper in individual poles from the average taper for the species (on which the derivation of the girth at 6 feet depends) affects the calculated ground-line strength very little.

As regards the third and fourth features, they take for granted poles to fail at ground-line so that it is the ground-line dimension that determines, from a practical standpoint, the strength of a wood pole.

An application of the above principles gives a new orientation to pole specifications as they then provide correlation of strength for any length and class (strength) of pole of the different species accepted for use as poles, and, secondly, for all lengths of poles within any one class. In fact, such a classification for wooden poles creates almost a parallel specification to that available for Hamilton sectional poles, with which the pole engineer with a minimum number of tables can determine the dimensions of the poles required in any specific case. That part of the fourth feature regarding the point of application of the resultant transverse load, as located at 2 feet from the top, is, of course, an arbitrary assumption, but it keeps the desired uniformity of strength for the various lengths of poles of any one class within narrow limits.

Features 5, 6 and 7 limit, to an economic minimum, the number of sizes and lengths that need be stocked. They establish limits of strength requirements which, in the writer's opinion, would be necessary according to present-day telegraph, telephone and electric distribution construction practices in India. The lowest breaking load corresponds approximately to the BC Hamilton pole, assuming a factor of safety of about $3\frac{1}{2}$, or to the AB pole if a factor of safety of $4\frac{1}{2}$ is employed.

As regards classes 8, 9 and 10, they are not governed by any classification table as their strength has to be determined by actual measurements of individual poles. They are either meant for very light loads or for special construction where the strength consideration is not so important as a minimum diameter at the top where certain attachments can be readily, conveniently and efficiently made. Further, these three classes help the producer to market poles which, though not meeting the top and ground line girth requirements of the first seven classes referred to above, will be quite suitable for certain special or general purposes, so that those consumers who, for reasons of their own, prefer to purchase poles on the basis of top dimensions can obtain them at a comparatively low cost.

One of the most notable features of the classification table (developed originally by the American Standards Association and

adapted by the writer to Indian conditions) is the *uniformity and independence between class and species.* Such characteristics are of special advantage in a country like India where there are several species of timbers that can be used for poles after treatment. The tables are based directly on their moments of resistance at the ground line so that *for any given class and length, all species are of equal strength.* When more data are available with reference to the durability life corresponding to a particular preservative treatment and certain maintenance costs, it may be possible to classify poles so that for any given class and length, all species are of equal strength and durability. Such correlations to an electrical engineer are of great value since they greatly help him in the ready selection of poles for any particular purpose he has in view. When once the poles are treated (as it is practically out of the question to use untreated poles of even the most naturally durable species in any permanent or semi-permanent type of construction in India), the species of timber concerned has no special significance. It is the method and nature of treatment that determine, in most cases, the durability of a pole.

The tables are so comprehensive that any straight pole of useful length that can be extracted from our forests and of any timber species finds a place somewhere in the classification.

A PRELIMINARY SURVEY OF THE FOREST TYPES OF INDIA AND BURMA

(Indian Forest Records—New Series, Vol. I, No. 1. By H. G. Champion.) Price Rs. 10-12-0 *or* 17*s.* 6*d.*

This is a pioneer book, the first attempt to draw up a standard classification of the forest types throughout India just as Schimper attempted to classify the types of vegetation throughout the world. The need for such a classification was urged at the Silvicultural Conference at Dehra Dun in 1929 with a view to co-ordinating the descriptions of types in working-plans and letting writers of working-plans know of other localities where types they were dealing with were to be found.

In his " Prefatory Note " the author writes : " The classification is published with the definite object of calling forth constructive criticism which will enable someone to revise and complete the much needed survey as soon as possible ; if it succeeds in eliciting this criticism it will have served its purpose."

Most of us know some of the types he describes much more intimately than the author possibly can, but few foresters in India at the moment have had the opportunities he has of seeing nearly all the types described even if, in some cases, " only from the railway carriage window." He has given us the broad outline, which must necessarily be sketched in by a single hand, and has tentatively filled in the detail over the whole canvas as a cockshy for our criticism. It is now up to us to correct his mistakes in the types we know best so that a revised edition may appear as soon as possible.

The author has wisely limited his use of ecological jargon to the barest necessities and the book is intended for the ordinary forest officer. I wonder whether this ordinary forest officer will have as much difficulty as I had in finding his way about it but after spending some hours in shuffling pages and puzzling out the arrangement, I offer him what I believe to be the solution in the hope of saving his time. We will suppose he wishes to look up the forest *type* in which he happens to be camped. He should first turn to " Types occurring in each province " (pp. 275—280) and, assuming that he can identify the *type* from its descriptive title, take a note of the cryptogram of letters and figures preceding it. If this begins with a figure (1a, 2b, etc.), he can turn directly to the contents on p. i and find the first page of the *group* in which his *type* occurs. If it begins with a capital letter (M. Tr. = moist tropical, D. Tr. = dry tropical or Tp. = (montane temperate), he will have to consult the second half of the cryptogram and search for his *type* on pp. 18-25 among the *edaphic* (E) or *seral* (1S = primary, 2S = secondary) variants in the appropriate sections. Once he has found the right *group* he should not have much difficulty in running his *type* down, no *group* occupies more than 14 pages and the *types* usually follow the straightforward sequence of the " Provisional Classification " on pp. 18-23—*usually* but not *always* (at this stage our ordinary forest officer hurls the book to the other end of his tent and decides that ecology is not for him)—for in Group 11 this sequence C1(*a*), C1 (*b*), etc., is suddenly abandoned for another, C1 (*a*), C2(*a*), etc., leaving the baffled searcher with the impression that his *type* has been left out altogether.

I have dwelt, at too great length perhaps, on the only serious fault I have to find with it because it may cause the book to be less used than it ought to be, and because it could have been easily remedied by giving page references against the *types* on pp. 18-23 and 275-280. Page headings would also have contributed towards easy reference, but in this the author had no doubt to conform to the standard of the series. To be told the name of the series, volume and number as well as the title of the book one is reading at the head of every page might, at first sight, seem unnecessary, but it is useful when a volume falls to pieces and the paper binding is quite inadequate for one of this size (and price).

I have noticed a few misprints but none likely to cause real confusion, though the letter press, in my copy at any rate, is disfigured by some blurred type, smudges and ragged alignment. The sub-tropical types have been omitted from the lists of types by provinces, pp. 275-280.* Northern moist bamboo brake is shown on p. 277 as one of the *types* found in the C.P., but this locality is not mentioned in the description of the *type* on p. 98.

I am not dealing here with what I believe to be mistakes in the subject-matter of the book. Such suggestions for amendments must be cleared up by correspondence with the author and I hope that others will take a hand at this, for every forester in India is a potential critic of this work and the more the criticism the better for the next edition.

The two coloured maps show the distribution of climatic types and of rainfall. One has been placed at the beginning and one at the end of the volume so that both should be visible when it is spread out on a table—an excellent idea frustrated by the press which has printed one of the maps at the wrong end of its strip. The rainfall map, in the usual shades of blue, is excellent but the other would have been clearer (and cheaper) if the artist had resisted the temptation offered by the three-colour process to exploit a wide range of mixed washes (which the colour printers have

* I understand that a revised copy of pp. 275-280 is being issued shortly giving these essential references and remedying the omissions referred to.

reproduced most skilfully and in good register in my copy) and used hatchings and stippling more. With red, blue and black at his disposal (I wonder when map-makers will realize that maps are sometimes used by artificial light and avoid yellow—including of course greens and oranges) he could have represented his 15 types with ease: as it is there is precious little difference between Nos. 2 and 6 even by daylight. A minor inaccuracy in this map is that the sub-himalayan *sal*-belt is shown to end eastwards about the Tista river except for a small patch which seems to be somewhere in the south of the Nowgong District of Assam.

The forty plates, beautifully reproduced over a pale blue wash, are not only works of art but give a really good idea of the types they illustrate, at least in so far as I am in a position to judge.

The author is to be congratulated on the thorough and scientific way he has carried out the very heavy task allotted to him.

In conclusion I will repeat myself once again to urge all who know Indian forests to get this book out of the nearest forest library and supply the constructive criticism for which the author asks.

Note by the Reviewer

After I had sent my review of " Indian Forest Types " to the author for his opinion, I discovered some further omissions in the provincial lists. I wrote to the author hurriedly and I am afraid not very clearly, asking him to amend one paragraph, to get a revision of pp. 275-280 sanctioned and to add the footnote to this effect. He misunderstood my letter and amended the wrong paragraph.

With his permission I am asking the Editor of the *Indian Forester* to be kind enough to publish the review again as I had intended it to appear as the altered paragraph rather affects the review as a whole.

My apologies are due to the author, the Editor of the *Indian Forester* and to anyone who read the review as first published in the *Indian Forester* for September 1937.

E. O. S.

HANDBOOK OF EROSION CONTROL ENGINEERING ON THE NATIONAL FORESTS

UNITED STATES FOREST SERVICE, 1936;

PREPARED BY W. T. NORCROSS

United States Government Printing Office, Washington, D.C.

It is unfortunate that this masterly summary of the erosion problem and the various means of dealing with it should not be available to the public, but it is a departmental production and therefore not for sale. Anyone who has to deal with practical erosion control should, however, try by some means or other to obtain a copy, for it is undoubtedly a masterpiece of brief and clear statement. In the space of 28 printed pages and somewhat more of diagrams and illustrations, it covers the entire field of soil conservation on uncultivated waste and forest lands.

A short introduction emphasizes two points, neither of which has yet been grasped by many land-owning agencies in India. The first is that erosion on forest land is merely a phase of a much wider problem, namely the proper conservation of the soil as the basic resource of all land values. The second is that all the various engineering approaches to erosion control must be regarded as merely a means to an end, the end being the establishment of the best possible plant cover under any given set of conditions of climate and use of the ground.

The list of possible methods of erosion control is so concise and so complete that one is tempted to quote it in full, because Indian attempts tend to follow locally one or other of these methods (*e.g.* the exclusion of grazing) to the neglect of several other feasible methods. " One or more of the following measures will be found necessary in the majority of cases :

(*a*) Elimination of those abuses of the land and its cover that are responsible for accelerated erosion (over-grazing, improper agriculture, fire, destructive logging, operation of smelters, road-making, etc.).

(*b*) Construct intercepting ditches on a very flat grade around the head of the eroded area, thus preventing run-off other than that from precipitation on the immediate area.

(*c*) Drop the intercepted run-off down a gully or ditch protected by means of check dams or paving.

(*d*) Construct a contour furrow system to reduce run-off and thus allow the vegetation to reclaim the eroded area. This system aids precipitation to percolate into the ground and thus conserves water.

(*e*) Construct a system of terraces having protected outlets and drops.

(*f*) Break down gully banks to smooth the surface and deposit top-soil in the gully bottoms. Sometimes cut pockets or ditches into side walls to hold top-soil to permit vegetation to get rooted.

(*g*) Plant the eroded area to some form of vegetation.

(*h*) Cover planted area with a mulch, brush, hay, straw, or other material to hold the loose soil in place and keep soil moist while vegetation gets started.

(*i*) Construct brush wattles to hold a loose slope and establish a growth of vegetation.

(*j*) Construct check dams in the gullies to prevent further cutting.

(*k*) Construct gully-head plugs to prevent the upward progress of the gullies.

(*l*) Construct check or soil-saving dams at such intervals and of such heights as to cause the gullies to fill up and so restore themselves.

(*m*) Construct diversion ditches to carry run-off away from large gullies to spreading works, another channel, or other place where it can be handled.

(*n*) Construct spreading structures below the outlets of ditches or channels to cause the run-off to spread and percolate into the ground.

(*o*) Construct debris basins with spreading structures for storing the debris from eroded areas, and thus preventing it from getting on improved property below.

(*p*) Construct training walls along flood channels to confine the flow and control the deposition of eroded materials.

(*q*) Treat ravelling stream banks by sloping and planting.

(*r*) Construct revetments or retaining walls along streams to prevent erosion of banks.

(*s*) Construct cross-checks in channels to prevent bed erosion.

Any practicable combination of the above control measures may be used on an erosion job. The nature of the soil and vegetation, topography, amount of precipitation, and economic considerations will determine the exact method of attack."

Then follows a series of examples chosen from actual United States projects and illustrated by very clear photos, and each is discussed to show the choice of methods eventually drawn from the list. The economic justification for such work is also discussed and an example given of estimated costs for one area dealt with under alternative control methods. An interesting point brought out is the heavy expense of *restoring* a gully to its original profile flush with the neighbouring land, compared with the cost of merely *stabilising* it at its present level, *i.e.*, reclothing it with plant cover and preventing the gully from cutting any deeper. Justification for erosion control jobs is classified under three heads, namely, value to local property owners; reduction of flood damage; the broader view of conservation of the national water-supplies.

Recent improvements in the scientific approach to this problem are shown in the chapter on Hydraulics of Erosion Control. The maximum expected run-off from various types and conditions of surface are given in graphs borrowed from C. E. Ramser's well-known data, but with local corrections based on meteorological data for the intensity of storms in the various climatic regions of the United States. Such calculations cannot, however, be applied to Indian conditions direct; apart from the difficulty of selecting a foreign climate which is exactly similar to a given set of Indian conditions,

there remains a very serious divergence in the fact that Ramser's figures give a higher run-off value for cultivated land than for pastures. This has been proved beyond question to be correct for American conditions, namely big stretches of plough land often on a considerable slope and in very large undivided units of field ; such ground naturally gives a heavier run-off than pasture land which *is* pasture with a real turf. Compare with these the typical Indian condition of very small fields, often carefully terraced to form self-contained catchments allowing little or no run-off, while grazing lands are totally neglected and often have little or no plant cover left upon them. One can thus grasp the essential differences. The very scanty data so far available show clearly that the American position is reversed and that in India grazing lands usually give a much heavier run-off than cultivated fields with similar slope and soil.

There is an excellent series of diagrams for the various types of gully structures such as check dams of rock, brush-wood, rubble masonry, wire, and logs. An interesting innovation here is the use of pre-fabricated corrugated iron check dams ready to place in position; these might be of value in India where local material is expensive or unsuitable. Soil-saving dams are dealt with separately and include a variety of pipe outlets to deal with the overflow and prevent it damaging the earth structure.

R. M. G.

EXTRACTS

PHYSICAL QUALITIES OF FOREST SOILS AND THEIR RELATION TO SOIL ACIDITY

BY ANTONIN NEMEC AND KAREL KVAPIL

(*Division of Silvics, United States Forest Service, Translation No.* 214, *June* 1935.)

Summary—From the results of our studies of the physical structure and the reaction of the upper mineral layers of the forest soils in different forest regions, the following conclusions may be drawn.

1. Of all the physical characteristics it is mainly the absolute air capacity of the soil which undergoes the greatest changes as a

result of growth of the stands. In dense conifer stands, where the bare floor is covered with a coherent litter and humus layer, the upper mineral layers are very poorly aerated. The unfavourable physical characteristics cause an accumulation of acid reacting litter and humus decomposition products so that the soils of the spruce and fir stands with permanently dense canopies have only a very low air capacity and at the same time a high acidity. The strong acid reaction and low air capacity of the soil are the chief causes of failure of natural regeneration of these stands.

2. The bad effects of these soil conditions may be prevented by proper and timely thinning of the canopy so that a more rapid litter decomposition can take place. All of the investigations showed that the soils of more open stands (open stands and plantations) have not only a lower acidity but at the same time a higher air capacity. In mineral soil layers of thinned conifer stands in which there is often a natural young growth of fir, spruce, oak, beech, ash, etc., the absolute air capacity is usually very high.

3. It is interesting to notice that in soils of coniferous stands the absolute air capacity is in direct relation to the reaction of the soils : by decreasing soil acidity the air capacity rises and *vice versa*.

4. The absolute water capacity is generally indirectly proportional to the air capacity ; in densely closed coniferous stands we noticed the highest water capacity ; in open formation and thinned stands, the water capacity decreases with increasing air capacity.

5. In pure hardwood stands (beech, oak, hornbeam, ash, maple, and alder), the soils of closed formations (closed stands and dense young forests) in which the characteristic floor surface is without vegetation, had a comparatively low air capacity. The aeration of these soils, however, was always more favourable than in the closed conifer stands, while the stocked forest soil shows a minimum air capacity. The acidity of the rhizophorous layers of closed hardwood stands was throughout lower than in corresponding layers of closed coniferous stands of the same region.

6. Open or thinned hardwood stands had a higher air capacity and at the same time a lower acidity than closed hardwood stands.

7. In pure hardwood stands, one may notice similar relations between the absolute air capacity and hydrogen-ion concentration of the soil as in conifer stands, although less pronounced : the acidity of the soil increases with decreasing air capacity.

8. In soils of mixed stands the absolute air capacity is subjected to wide fluctuations. In mixed stands, soils which are covered with humus and without undergrowth have, on an average, a higher absolute air capacity than in corresponding layers of closed conifer and hardwood stands. These values approach those which had been ascertained for soils of the open hardwood stand formations. Generally, however, the absolute air capacity of the soil-layers in the mixed stands is lower than in open planted or thinned conifer stands.

9. A direct relation between soil acidity and air capacity, such as was ascertained in the soil-layers of conifer and hardwood stands, could not even be approximated for the soils of mixed forests.

10. Denuded forest soils, such as clear-cut areas, often have a very low air capacity and a correspondingly high water capacity.

11. Our studies have recently supported the views of Kopecky and Berger, namely, that favourable air capacity is a distinguishing feature of good site class and fertility of the forest soils. A typical proof of this is the case of two neighbouring young ash forests of the same age which we studied, and which presented a wide difference in development. The investigation showed that the soil sample from the well developed stand has five times as great an air capacity as the neighbouring poorly developed young forest.

12. The absolute air capacity may be looked upon as a very important aid in judging the influence of stand growth, silvicultural measures, and the characteristics of forest soils. Beside the influence of the stand, one may, in special cases also notice the influence of the forest vegetation on the soil conditions. Where there is a dense forest vegetation, the influence of this vegetation may strongly retard the effect of the stand on the soil. According to Cajander there are three principal types of forest vegetation that can be distinguished : *Oxalis*, *Myrtillus* and *Calluna* type. Of these three main groups, the first would correspond to a medium acid reaction and a very high

air capacity, the second type would correspond to that of the *Vaccinium*, having its optimum growth in a somewhat higher acidity and lower air capacity while the last, the *Calluna* type, has the highest acidity and the lowest air capacity, as we found in our investigations.

In bare soils, where only the effect of the stand on the soil characteristics is noticeable, the determination of the air capacity is one of the most important criteria for the valuation of forest site class. The reaction of the soil completes the results of the physical soil investigation. Genetically, the acidity may be looked upon as a secondary phenomenon which originates partly from the conditions of the given or still forming soil structure.

[It is curious that denuded areas and dense crops should have low air capacity of soil and low PH, while open stands have high air capacity and are less acid. Results may be quite different in the tropics.—HON. ED.]

TIMBER

The Board of Trade returns place the value of the imports of manufactured timber from all sources of supply to the United Kingdom during the six months ending June 1937 at £19,811,040 as against a value of £14,404,547 during the corresponding period of 1936. Of these imports, hardwoods, hewn and sawn, totalled 463,600 cubic tons valued at £3,364,100 in 1936.

In addition to the above 7,518,000 cubic feet or plywood valued at £2,218,909 were imported during the first six months of 1937 as against 6,977,500 cubic feet valued at £2,010,898 during the first six months of 1936.

The returns do not yet differentiate imports from Burma. Imports of sawn teak, mainly from Burma, were 25,840 tons valued at £553,751 during the first six months of 1937 as against 22,700 tons valued at £429,338 during the first six months of 1936. Figures for the imports of other timbers from India and Burma are not available.

Sales through the medium of this office totalled 118 tons and deliveries 108 tons during the quarter.

Apart from some railway enquiries for ***gurjan*** there has not been very much demand for Indian hardwoods during the quarter. I understand that the demand for rosewood on the Continent is temporarily at a standstill owing to the very large quantities that have been arriving recently.—(*Extract from the Report of the Indian Trade Commissioner, London, for the quarter ending June* 1937.)

THE VICEROY'S SPEECH AT THE OPENING OF THE FOREST CONFERENCE IN NEW DELHI IN DECEMBER 1937

In his speech at the opening of the Forest Conference in New Delhi His Excellency the Viceroy indicated the directions in which and the extent to which the Government of India could assist Provincial Governments in regard to forest administration.

His Excellency said :

" I must first say how great a pleasure it is to me to be able to come here this morning to open this Conference. As you all know, I am closely interested in the question of forests in India and their allied problems, and I look forward to the results of your deliberations, the importance of which to forest administration in India I fully appreciate.

" I do not propose in the few words which I address you to-day to make any endeavour to discuss possible lines of development and organization. The material wealth of India in forests is very great and the importance of forests as an economic asset calls for no emphasis from me.

VALUE OF FORESTS.

" We are all of us well aware of the contribution which the forest yield of this country makes to the maintenance of one of the most precious of its economic assets, its livestock. And we are sensible, too, of the value of forests to agriculture, and of their beneficent influence on climate, on water conservation and on erosion.

" To realize how important it is to retain the natural protection afforded by forests and how conspicuously fortunate India's record in this regard has been, one has only to look round at other countries and to see how in some, large areas of land, unsuited for permanent cultivation which were alienated from forests and made into farms, have now been abandoned to waste and desolation and in others how forest denudation has led to flooding or dust-storms which have brought widespread destruction and misery in their train.

" The scientific attention which the various Governments in India and the services working under them have for so long a period of years paid to the forests of India has achieved results of inestimable value ; and the long record of conservation and development which has earned for India so prominent a place in the list of countries confronted with the care of great forest resources is one on which we can all of us reflect with pride.

Effect of Reforms.

" This is the first Conference since the introduction of provincial autonomy in April 1937 and it is inevitable that we should reflect a little on the working of the new Constitution in relation to this particular form of administration. Even before April **1937** " Forests " were a transferred subject ; but the effects of constitutional reforms of such magnitude as those recently introduced cannot but be felt in every sphere of governmental activity, and especially where economic assets as vast as the forests of India are concerned.

"With the inauguration of provincial autonomy the responsibility for the conservation and the handling of the forest wealth of India passed in fuller measure to Ministers elected by the people. I welcome this opportunity of saying how sincere is my belief and how deep my confidence that the new Ministries will be as zealous as any of their predecessors to conserve and to develop even further the forest resources which are now under their control. I am confident, too, that in their work they can look for the loyal support and the disinterested advice of the members of the Forest Services whose contribution in the past has been of such great value,

Policy and Administration.

"Policy and administration alike are as a result of the recent constitutional changes the exclusive responsibility of Provincial Governments. But let me for a moment dwell on the position of the Government of India in the new Constitution in regard to forest administration, and indicate very briefly indeed the direction in which and the extent to which it can be of assistance to Provincial Governments.

"You will agree with me that forest administration is a subject which by its very nature does not admit, if the best results are to be achieved, of isolation within the boundaries of any single province. Efficiency to-day is achieved and maintained only by a constant effort to keep up to date, by the persistent acquisition of knowledge of general conditions and of new scientific discoveries, by comparison of method and the like.

"If we consider it also from another aspect, timber is a commodity of world-wide economic importance, and no producer to-day can afford to disregard the demands of his market or the technique of his competitors when that technique enables them to place better or cheaper goods on the market.

Value of Consultations.

"The fact that each Province is responsible for its own forest wealth does not, I suggest, weaken the need, or diminish the advantage, of periodical consultation with a view to the exchange of ideas and, where this may prove to be desirable or feasible, of active co-operation.

"I suggest that this is one of the directions in which the Government of India can well be of assistance to the Provinces, and can most appropriately and conveniently afford the facilities for periodical discussion of the kind which I have mentioned.

"I need only refer to the invaluable work which has been done by the Imperial Council of Agricultural Research and by the Central Advisory Boards of Education and of Public Health as an instance of the assistance which can be given in this way without in any way

interfering with or impinging on the legitimate sphere of the Provincial Governments and the responsibilities which have now been transferred to them.

" There is another direction in which I think the Government of India can be of real assistance, and in which it is only too ready to continue to make its assistance available. I refer to the importance of the application of science to the development of the forest resources of India.

" I feel no doubt myself that the eminent degree of success which has in the past been achieved in the conservation and development of forests in this country has to a very great extent been due to the high standard, universally recognized, of scientific attainment among members of the Forest Services.

Training of Officers.

" As you know facilities exist at Dehra Dun for the training of officers in the more scientific aspects of forest work which in the future, as in the past, the Government of India are only too ready to place at the disposal of the provinces. And in another area of this field, the Forest Research Institute at Dehra Dun is an institution admirably equipped for the forwarding of research, the value of which to the conservation and utilization of the forest wealth of India needs no emphasis from me.

" I have myself had the pleasure more than once of visiting the Institute and of examining its admirable equipment. No one who has had the opportunity of inspecting it can fail to be impressed by the excellence of its equipment, by the quality of the work which has been and is being done, and the opportunities which an institution of this character affords.

" I am aware that the Institute has been criticized in the past on the ground that it tended to isolate itself from the provinces and from industry for purposes of effective collaboration in the practical application of knowledge attained and recorded within it. Whatever foundation there may have been for that criticism in the past, active steps have been and are being taken to improve conitions in this

regard. A special Utilization Branch has been established; everything is being done to encourage touring by the officers of the Institute; and in particular, and to this I attach much importance, active steps are being taken to pursue propaganda in non-technical language.

"Gentlemen, the facilities are there and their advantages are patent. It must be for the provinces to decide to what extent they desire to make use of those facilities, whether for co-operative consultation, for research, for instructional purposes or for the wider and more profitable utilization of the forest wealth of India.

"That existing methods and existing machinery may in certain respects need modification if they are to give the fullest value in modern conditions may well be the case. But I can assure you, Gentlemen, that any constructive suggestions designed to this end which may be made either by this Conference as a whole, or, after the Conference closes, by its individual members, shall have the closest and most sympathetic consideration. And I can assure you, too, that not only on general grounds but because of my own close and active concern with agriculture and the allied fields of plant and animal husbandry, you can rely on my personal interest in any action that may be needed in that respect.

STATISTICS.

"Before concluding my speech I would like to concentrate your attention on the magnitude of the work in the hands of forest administrations in India. The day-to-day concern with the immediate problems of one's particular field of work sometimes tends to produce a lack of perspective. It is then that it is useful to have the picture as a whole brought before one's mind.

"In order to appreciate this for myself I examined the other day the latest figures dealing with forest matters for the year 1933-34. These were so striking that with your permission, Gentlemen, I will quote them to you. Burma with its great forest areas has now been separated from India, but even so there still remains in India a total area of 99,746 square miles of forest of which 71,357 square miles are reserved.

" The total number of animals grazed in that year was over eleven and a half million. The total value of wood and timber exports was over Rs. 20 lakhs. The gross forest revenue exceeded Rs. 2½ crores, of which over Rs. 2 crores were spent in meeting the charges of forest administration.

" These figures give some idea of the material forest wealth of India and of its contribution to the maintenance of India's livestock. The responsibility of administering assets as large as these is a very great one, and one which cannot but have a material influence on the discussions of this Conference.

" Whether these discussions are concerned mainly with service matters or whether they deal with the wider questions of development and utilization, your decisions and recommendations must be important. That they will be for the better administration of the great forests of India I have no doubt. I wish your deliberations, Gentlemen, every success."

On his arrival, the Viceroy, who was accompanied by the Private Secretary and the Military Secretary, was received by Kanwar Sir Jagdish Prasad and Sir Girja Shankar Bajpai and escorted through the red carpeted stairs to the Conference room in the South Block.

In requesting the Viceroy to open the Conference, Sir Jagdish Prasad said :

" It is my proud and happy privilege to welcome Your Excellency to this Conference which represents another effort during Your Excellency's Viceroyalty, to bring together the provinces, the Indian States and the Centre to discuss those matters of common interest which touch intimately the well-being of the people. The Conference is also noteworthy in that Hon'ble Ministers representing autonomous provinces are taking part in its deliberations. That Your Excellency should be pleased to inaugurate it is a further token of your deep and abiding interest in all that promotes the health and agricultural welfare of the masses.

" Your Excellency is not content with expressing merely verbal sympathy for the man behind the plough but you are genuinely anxious

to get something done, something achieved to make his life a little sweeter. I am sure that enough will have been accomplished before Your Excellency lays down your high office, which will make posterity look back with gratitude upon Your Excellency as a sincere friend and helper of the poor and as the illustrious author of far-reaching policies for the betterment of the people.

FODDER FOR LIVESTOCK.

" Your Excellency, our forest policy, in its earlier years, concentrated on the commercial aspect and did not pay sufficient attention to the needs of agriculture. That, however, was remedied soon after and the broad lines of policy were laid down by the Government of India in 1894 and have been followed since. Forests are now regarded not only as valuable suppliers of timbers for commercial purposes, but as important sources for the supply of fodder for livestock, fuel and small timber for the rural population, apart from their influence on climate, on the conservation of the water-supply, on the flow of streams and rivers and the prevention of erosion of the soil.

" Bitter experience has taught Governments in many parts of the world that without a sound and long range policy of scientific management irreparable damage might be done to the economic life of a country by the unrestricted destruction of forests. With the growth of population there is constant pressure to bring the more accessible forests under cultivation. Policy had to adjust itself so as to meet legitimate needs without at the same time destroying the sources from which those needs can be met.

" We in this country owe a debt of gratitude to those who in the past have by their farsightedness saved our magnificent forests from destruction and have handed down to us the traditions of sound and efficient administration. And that leads me, Your Excellency, to mention, in passing, what I regard as one of the most important questions for the decision of this Conference.

HIGHER TRAINING.

" It seems to me a matter of some regret that while we have these great forests there is no provision in this country for the higher training

of our staff. We only provide at present for the teaching of subordinates. For a brief period between 1926 and 1932 Indian candidates were trained for the Imperial Forest Service, but after that we have been content to depend on foreign countries for higher education in forestry. I see no valid reason why in this respect we should not be self-sufficient.

" We have in Dehra Dun a fine Institute with a distinguished record both in teaching and research. We have the men and the material, and there seems no reason why Dehra Dun should not become in time one of the foremost forest institutions in the world. I do not deny for one moment that the question as to how and where the future members of the Forest Service in India will be trained is undoubtedly one for Provincial Governments to decide, but in taking that decision Hon'ble Ministers or their representatives will not, I hope, consider my remarks as irrelevant.

" The agenda of the Conference has been kept short deliberately in order that important questions may receive adequate attention. I sincerely trust that with the co-operation of Hon'ble Ministers from Provinces, with the help of representatives of Indian States and with the encouragement afforded by Your Excellency's presence here to-day our deliberations will lead to fruitful results. I thank Your Excellency for the honour which you have done us in coming here to-day."

The following attended the Conference :

The Hon'ble Kunwar Sir Jagdish Prasad (Chairman), Sir Girja Shankar Bajpai, Mr. L. Mason, Mr. G. S. Bozman, the Hon'ble Mr. V. I. Munswami Pillai (Madras), Mr. T. A. Whitehead (Madras), the Hon'ble Mr. P. D. Raikut (Bengal), Mr. W. Meiklejohn (Bengal), Mr. F. J. A. Hart (Bengal), the Hon'ble Sir Sundar Singh Majithia (Punjab), Mr. M. L. Darling (Punjab), Mr. R. N. Parker (Punjab), Mr. H. M. Glover (Punjab), the Hon'ble Khan Mohammad Abbas Khan (N.W.F.P.), Mr. G. D. Kitchingman (N.W.F.P.), Mr. R. Dhanukoti Pillai (Travancore), Mr. M. Machaiya (Mysore), Mr. S. A. Kabir (Mysore), Mr. Ramaswamy (Mysore), the Hon'ble Mr. Bodhram Dube (Orissa), Mr. J. W. Nicholson (Orissa), Sir Theodore Tasker (Hyderabad), Nawab Hamid Yar Jung Bahadur (Hyderabad), Mr. A. C. Hiley (Bombay), Mr. E. A. Garland (Bombay), Mr. A. A. Waugh (U.P.), Mr. E. A. Smythies (U.P.), Mr. Krishna Ballabh Sahay (Bihar), Mr. J. W. Houlton (Bihar), Mr. C. E. C. Cox (C.P.) and Mr. C. G. M. Mackarness (Assam).

(*Statesman*, 10th December, 1937.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for October, 1937:

IMPORTS

ARTICLES	MONTH OF OCTOBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
Siam ..	15	..	..	1,353	..	..
French Indo-China ..	..	42	..	..	5,042	..
Burma ..	..	..	14,800	..	..	18,32,851
Other countries ..	148	..	117	14,943	..	20,131
Total ..	163	42	14,917	16,296	5,042	18,52,982
Other than Teak—						
Softwoods ..	934	2,120	2,547	56,110	1,30,973	2,11,726
Matchwoods ..	..	648	780	..	38,290	48,035
Unspecified (value) ..	..	..	..	1,74,527	27,423	2,74,050
Firewood ..	58	28	28	870	414	420
Sandalwood ..	20	47	20	8,541	13,799	10,071
Total value of Wood and Timber ..	..	..	..	2,56,344	2,15,941	23,97,284
Manufactures of Wood and Timber—						
Furniture and cabinet-ware ..		No data			No data	
Sleepers of Wood ..	..	..	128	..	..	12,024
Plywood ..	..	192	225	..	49,545	46,681
Other manufactures of wood (value) ..	..	..	..	2,12,572	1,21,212	1,26,565
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,12,572	1,70,757	1,85,270
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	17,072	16,404	15,320	1,10,235	1,01,454	1,07,102

EXPORTS

ARTICLES	MONTH OF OCTOBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	3,218	3,752	40	6,27,697	7,79,106	5,000
" Germany ..	421	740	..	98,980	1,75,867	..
" Iraq ..	57	30	1	12,129	4,936	130
" Ceylon ..	118	62	..	14,120	13,624	..
" Union of South Africa ..	223	570	..	39,929	1,15,259	..
" Portuguese East Africa ..	154	131	..	25,317	22,051	..
" United States of America ..	17	..	..	3,766	..	..
" Other countries ..	557	592	66	1,03,128	1,41,755	20,522
Total ..	4,765	5,877	107	9,25,066	12,52,598	25,652
Teak keys (tons) ..	428	355	..	62,500	49,393	..
Hardwoods other than teak ..	88	159	5	10,282	16,050	1,480
Unspecified (value) ..	..	..	..		..	..
Firewood	1	..	..	11	..	..
Total value ..	..	..	..	72,793	65,443	1,480
Sandalwood—						
To United Kingdom ..	..	..	..	..	..	..
" Japan ..	17	15	10	19,100	39,828	10,100
" United States of America ..	..	4	64	..	2,300	64,600
" Other countries ..	3	13	23	3,660	14,625	20,020
Total ..	20	32	97	22,760	57,353	94,720
Total value of Wood and Timber ..	..	..	..	10,31,524	14,44,850	1,85,177
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)..	..	..	..	9,810	15,987	41,609
Other Products of Wood and Timber ..	No data			No data		

INDIAN FORESTER

FEBRUARY, 1938.

EDITORIAL

EFFECT OF BURNING OF SLASH ON SOIL AND SUCCEEDING VEGETATION

The United States Forest Service Division of Silvics has issued an interesting translation from the German of Professor Fabricius on "The effect of ashes upon germination and the early development of tree seedlings." It is well known that the purpose of burning worthless slash is either its destruction as detrimental to reproduction or for the prevention of accidental forest fires, still more frequently for the fertilization and improvement of the soil for the benefit of the new forest or agriculture crop. The effect of burning slash, however, will to a great extent depend upon the intensity of the fire, that is upon the quantity of combustible material. To test the effect of burning upon the development of the new crop, the Bavarian Institute for Silviculture and Forest Utilization has started experiments which can only show results after a lapse of years. Meanwhile, laboratory experiments carried out by Heikinheino have shown that of the seven species examined none were in any way favoured by fresh ashes of the type resulting from a forest fire either in germination or early development. On the contrary the ashes were always harmful generally reducing the germination per cent. and plant survival.

This appears to be quite contrary to Indian experience. Sowing deodar in burnt heaps of slash results in greatly increased development; the same result is obtained with the standard *rab* system of regeneration in Bombay and Madras. In Burma a good burn is considered essential for a successful *taungya* plantation and every *jhum* cutter in India will agree with this proposition. It has been stated that burning reduces the protozoa population of the soil, thereby increasing the activity of nitrifying bacteria and that this is one of the reasons for increased growth. Also the burning probably provides increased potash in available form. Whatever the reasons

may be every practical forester will agree generally on the benefits in weed control and accelerated growth obtained by the use of fire under Indian silvicultural operations. Burning is also employed as a silvicultural operation in the natural regeneration of sal for the purpose of converting an evergreen undergrowth into grass, thereby making use of the well-known fact that fire puts back succession and favours savannah at the expense of forest.

In the case of the Eucalypts, fire is considered essential for their reproduction in Australia and the only known cases of natural regeneration of these trees in India has been the result of accidental fire. Profuse regeneration of *Adina cordifolia* following slash burning has also been observed in the United Provinces.

On the other hand the benefit of burning after clear felling has been questioned in the case of the plantations in Darjeeling where coppice regrowth is desired as part of the new crop; and the utility of brushwood burning in the Punjab irrigated plantations has from time to time been debated. Slash burning in the wattle plantations of Natal has, as the result of Craib's research, been given up in favour of piling in rows.

As this matter is of such great interest to Indian forestry we publish *in extenso* (under extracts) the article by Professor Fabricius who is a prominent member of the International Union of Forest Research Institutes, and acknowledge with gratitude the work of the Division of Silvics of the United States Forest Service in providing the English translation.

It is possible that the effect of fire is entirely different in the tropics to what is the case in temperate climates and that any results obtained in Europe will be entirely inapplicable to India.

We would welcome correspondence on this subject in our pages and should be glad to have some scientific interpretation of the effects of slash burning on the soil and the succeeding vegetation. What changes in the soil in actual fact are brought about by fire? how do these changes affect plant life? how long do they persist? We are here not concerned with slash burning carried out for purposes of fire-protection or the mere removal of an impediment to natural regeneration, but with the almost universal belief in India that a good burn is essential for the making of a good plantation. What scientific authority is there for such a belief?

Delegates who attended the Forestry Conference in New Delhi in Dec. 1937.

Seated left to right.- Sir Theodore Tasker (Hyderabad); Sir Girja Shankar Bajpai; Honble Khan Mohammad Abbas Khan (N.W.F.P.); Honble Mr. P.D. Raikut (Bengal); Honble Kunwar Sir Jagdish Prasad; His Excellency the Viceroy; Honble Mr. V.I. Munuswami Pillai (Madras); Honble Sir Sunder Singh Majithia (Punjab); Honble Mr. Bodhram Dube (Orissa); Mr. L. Mason, I.G.F., Mr. A.A. Waugh (U.P.).

Standing middle row- Nawab Hamid Yar Jung Bahadur (Hyderabad); Mr. A.C. Hiley (Bombay); Mr. T.A. Whitehead (Madras); Mr. R.N. Parker (Punjab); Mr. E.A. Garland (Bombay); Mr. J.G. Laithwaite; Mr. J.W. Nicholson (Orissa); Mr. J.W. Houlton (Bihar); Mr. W. Meiklejohn (Bengal); Mr. F.J.A. Hart (Bengal); Mr. C.E.C. Cox (C.P.); Mr. R. Dhanukoti Pillai (Travancore); Mr. G.S. Bozman.

Standing last row.- Mr. Bonnarjee; Mr. H. Trotter; Mr. C.G.M. Mackarness (Assam); Mr. M.L. Darling (Punjab); Mr. R.S. Mani; Mr.M. Machaiya (Mysore); Mr. E.A. Smythies (U.P.); Mr. S.A. Kabir (Mysore); Mr. Ramaswamy (Mysore); Mr. G.D. Kitchingman (N.W.F.P.); Mr. H.M. Glover (Punjab).

FORESTRY CONFERENCE IN NEW DELHI, DECEMBER 1937

We published the speeches of His Excellency the Viceroy and Sir Jagdish Prasad in the last issue. After two days of discussion the Conference adopted the following resolutions:

No. I.(i) This Conference is of the opinion that ordinarily there should be only one superior service in each province, direct recruits to which should receive their training at Dehra Dun.

(ii) That, for the aforesaid training, provision should be made with effect from 1st April 1938 at the Forest Research Institute, Dehra Dun. The instruction should be of the highest standard necessary for Indian requirements. For this purpose, only the most highly qualified staff should be employed.

No. II. The Conference is of opinion that, considering the highly specialised qualifications required for the India List posts which the Government of India propose, subject to the approval of the Secretary of State, to reduce practically to the minimum necessary to fill research and educational appointments at Dehra Dun, allocation of these posts to provinces by designation or numbers is not practicable. Realising the benefits to India and to themselves of these posts being filled by men of the highest qualifications, provinces will be prepared to lend, so far as possible, the best available officer for the purpose, and the Government of India will pay for his services during the period that they employ them according to the ordinary deputation rules.

No. III. The Conference is in general agreement with the principles of Forest Policy stated in the Government of India Resolution No. 22-F, dated 19th October 1894, and recommends to Provincial Governments that, in any amendment of the Indian Forest Act or their Forest Manuals that they may undertake, these principles should be maintained.

The Conference also recommends that no proposal for large-scale disforestation should be approved by a Provincial Government except after the fullest consideration by the Council of Ministers. Where any such proposal is likely to affect another Province or any State, no decision should be taken except after consultation amongst the Governments concerned.

No. IV. The Conference is of the opinion that the advice of the Inspector-General of Forests will continue to be of value to Provincial Governments and that he should, therefore, be allowed to visit provinces with their consent. He should also be permitted to correspond direct with Provincial Heads of Forest Departments on technical questions so as to keep in touch with developments in each province.

In addition, better utilization of forest products was also considered and a useful interchange of views took place.

THE FINANCIAL POSSIBILITIES OF PLANTATIONS

BY B. E. SMYTHIES, I.F.S.

(*Continued from pp.* 814—26 *of the "Indian Forester" for December* 1937.)

1. Controversy has raged in the past over the rate of interest applicable to capital expenditure on forest operations. Owing to the long periods involved the matter is of great importance, and a difference of even 1 per cent. may lead to very material alterations both in the prospects of profit and in the financial rotation. Mr. Atkinson in his valuable and very interesting note in the *Forest News Bulletin* for February has taken the figure of $2\frac{1}{2}$ per cent. which he describes as "the normal rate of interest" and later he writes "Assuming 2.5 per cent. as being the rate at which money can be obtained for investment in forestry," but he does not give any reasons or authority for taking this particular figure.

2. A Government may incur capital expenditure in forestry for two reasons:

(*a*) Because forestry appears to be a good investment, and to offer a rate of interest as high or higher than that offered by gilt-edged securities or trustee stock.

(*b*) Because it becomes necessary to start a plantation or carry out some other forest work in order to safeguard the welfare and happiness of the people—a classical example of this is the afforestation of the maritime areas of the Landes by the French Government. To check the invasion of the sand dunes which were rapidly spreading inland,

afforestation was carried out at great expense and no attempt was made at a financial forecast; a barren waste was ultimately converted into a densely populated area. Another good example is the afforestation of large areas in N.-W. India to prevent erosion. The loss sustained by the Government represents the cost of the indirect benefits accruing from the work done and is comparable to the loss incurred in building a large bridge for military or strategic purposes. In the one case protection is afforded against an invasion of sand or flood and in the other against an invasion of an enemy.

Teak plantations generally come under (*a*) and should be considered as a purely business proposition. It may become necessary in parts of Burma to work large areas of forests for fuel on a short rotation to supply the needs of the local population. If worked at a loss such areas would come under the second heading.

3. The older economists such as Pressler and Judeich were agreed that owing to the interval of time which must elapse in the production of forest crops compound interest must be introduced into the account, and it was generally accepted that the rate of interest so introduced should approximate to that earned by gilt-edged securities. Forestry was regarded as an investment which under good management offered good security, so that people would be content with a small rate of interest. The Great War upset the rate at which Governments could borrow money, and it rose from 2-2½ per cent. to 4, 5, 6, and even 7 per cent. in a short period. The majority of the loans were issued at 4-5 per cent.

The longest term Indian Public Loans at present quoted are:

	Sterling.	
4½ per cent.	1950—55,	110¾
3½ " "	1954—59,	102½
	Rupee.	
4 " "	1960—70,	110⅞
3 " "	1961—66,	97⅛

The 3 per cent. loan is a little below par, the 3½ per cent. loan is a little above par and the 4 and 4½ per cent. loans are well above par. This suggests that a long-term loan, such as would be needed to finance a plantation scheme, could be floated at the present time at

between 3 and 4 per cent. The figure depends on the credit of the Indian Government, on the amount of trust which the people put in its financial stability, and will fluctuate from time to time. The newly constituted Burma Government would probably have to pay a slightly higher rate of interest, and as Mr. Atkinson has taken the low rate of $2\frac{1}{2}$ per cent. it may be interesting to take the figure of 4 per cent. and to see to what conclusions it leads.

4. The cost value of the growing stock is given by the formula (Schlich, p. 133):

$$^{r}Gc = (Sc + E)\ (1{\cdot}0p^{r}-1) + c \times 1{\cdot}0p^{r} - \Sigma\, Ta \times 1{\cdot}0p^{r-a}$$

and the expectation value of the soil by the formula (Schlich, p. 131)

$$Se = \frac{Yr + \Sigma\, Ta \times 1{\cdot}0p^{r-a} - c \times 1{\cdot}0p^{r}}{1{\cdot}0p^{r}-1} - E \text{---}(1)$$

Whence $Yr = (Se+E)\ (1{\cdot}0p^{r}-1) + c \times 1{\cdot}0p^{r} - \Sigma\, Ta \times 1{\cdot}0p^{r-a}$

and hence profit $Pr = Yr - {}^{r}Gc = (Se - Sc)\ (1{\cdot}0p^{r}-1)$

$$\text{or } \therefore\ Se = \frac{Pr}{1{\cdot}0p^{r}-1} + Sc \text{------}(2)$$

This is a useful equation for working out the value of Se, as the value of Pr is given in column 11 of the yield tables. It is perhaps worth pointing out that as the cost and maintenance of the F. R. H. at Kyetpyugan has been included in the value taken for E, the present value of the building (B), divided by the area of the plantation should be added to the profit, *i.e.*, $Pr = (Se\text{-}Sc)\ (1{\cdot}0p^{r}\text{-}1) + \frac{B}{area}$

5. So far we have not considered the value of the soil. In areas unsuitable for rice cultivation the value may be taken as nil, but elsewhere, *e.g.*, in many of our plains reserves, the cost value of the soil (Sc) must be brought into the account. By far the most suitable value to take is the capitalized value of the land revenue which would be obtained if the reserve was disforested and converted into rice fields. The sanctioned rates for first and second class paddy lands in the Tharrawaddy Assessment tracts are 4/- and 3/- respectively and it is estimated that the land would be assessed as first class about 10 years after clearing (these data were kindly supplied by Mr. C. J. Richards, Deputy Commissioner of Tharrawaddy). The

capitalized value of a rental of 3/- per year for 10 years followed by a rental of 4/- per year for ever is 94.6/- say 95/-. This may be taken as a maximum value for Sc because the land would probably not be assessed for revenue during the first two or three years; at any rate it would not pay the full rate of 3/-. Financial Yield Table No. 2 shows the effect of bringing the value of the soil into the account.

6. In order to calculate the mean annual forest per cent. equation No. 1 was solved by taking a set of values for p (4, 5, 6, 7, 8, 9 and 10 per cent.) and calculating Se for the different rotations from 20 to 70 years for each value of p. The results are given in Table No. 3. An indicator graph was then prepared by plotting Sc against r, and a curve obtained for each value of p. From the graph the mean annual forest per cent. can be read off for any given soil value and any rotation between 20 and 70 years. We are concerned with two values Sc=O and Sc=95 and the mean annual forest per cents. for these values are shown in column 15 of the two yield tables (1 and 2).

7. A contemplation of these curves leads to the following conclusions:

1. The financial rotation lies between 25 and 30 years for all values of p., *i.e.*, for this particular plantation the rate of interest at which money is available for investment in forestry has little or no effect on the financial rotation. For reasons given by Mr. Atkinson in his para. 5, a rotation of 40 years would be preferable in practice.
2. On a rotation of 30 years the plantation will yield over 10 per cent. compound interest if the soil cost is taken as nil and 5.2 per cent. if the soil is taken as 95/-. The marginal value of the land is 177/-; this means that the plantation would not show a profit on land assessed for land revenue at 7/- per acre. If the Government floated a loan at 4 per cent. to finance the plantation on such land, the plantation would yield just sufficient to pay the interest of 4 per cent. on the capital borrowed, or if the plantation is regarded as an investment for

surplus capital, a return of 4 per cent. compound interest would be received on the money invested.

3. This leads to the important fact that the *prospects of profit to Government are greater under forestry than under rice cultivation.* The plantation will yield 5.2 per cent. compound interest on a 30 years' rotation whereas the land revenue obtainable for first class paddy land is only 4 per cent. (we obtained the soil value of 95/- by capitalizing the land revenue at 4 per cent.). Disforestation of plains reserves analogous to Kyetpyugan would therefore lead to financial loss, and only when the land revenue obtainable under rice cultivation exceeds 7/- per acre will disforestation be financially justifiable. Whether the Government should incur such loss in the interests of the local population is a question to be decided on grounds of general policy.

TABLE No. 1.

Financial Yield Table for Kyetpyugan Teak

Assuming p = 4 per cent. Se = 0

Rotation.	Net value of yields. Final.	Net value of yields. Intermediate.	Sum of intermediate yields with interest at 4 per cent. to date.	Total yield to date.	Cost of formation 25/- with interest to date.	Cost of intermittent expenses with interest.	6+7	Total yield less all costs other than annual, 5—8.	Annual costs with interest to date.	Profit 9—10.	Value of $\frac{1.04^r-1}{.04}$	Gross rental, 9/12.	Net rental, 13—1·25 annual costs.	Mean annual forest per cent.	Indicating per cent during each period of 10 years.	Expectation value of the soil Se.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
															Per cent.	
(15)	..	25														
(20)	218	40	30	248	54·8	3·3	58·1	190	37·2	153	29·8	6·38	5·13	10·1	5·8	128·6
30	450	145	104	554	81·1	4·9	86·0	468	70·1	398	56·1	8·34	7·09	10·2	2·6	177·5
40	450	130	369	819	120·0	7·2	127·2	692	118·8	573	95·0	7·29	6·04	9·0	1·9	150·8
50	520	100	738	1,258	177·7	10·7	188·4	1,070	190·8	879	152·6	7·01	5·76	8·5	1·8	143·8
60	500	30	1,241	1,741	263·0	15·8	278·8	1,462	297·5	1,164	238·0	6·14	4·89	8·1	..	122·0
65	500	..	1,547	2,047	320·0	19·2	339·2	1,708	368·7	1,339	294·9	5·79	4·54	8·0	1·2	113·4
70	460	..	1,882	2,342	389·3	23·4	412·7	1,929	455·3	1,474	364·2	5·30	4·05	8·0	..	101·2

TABLE No. 2.

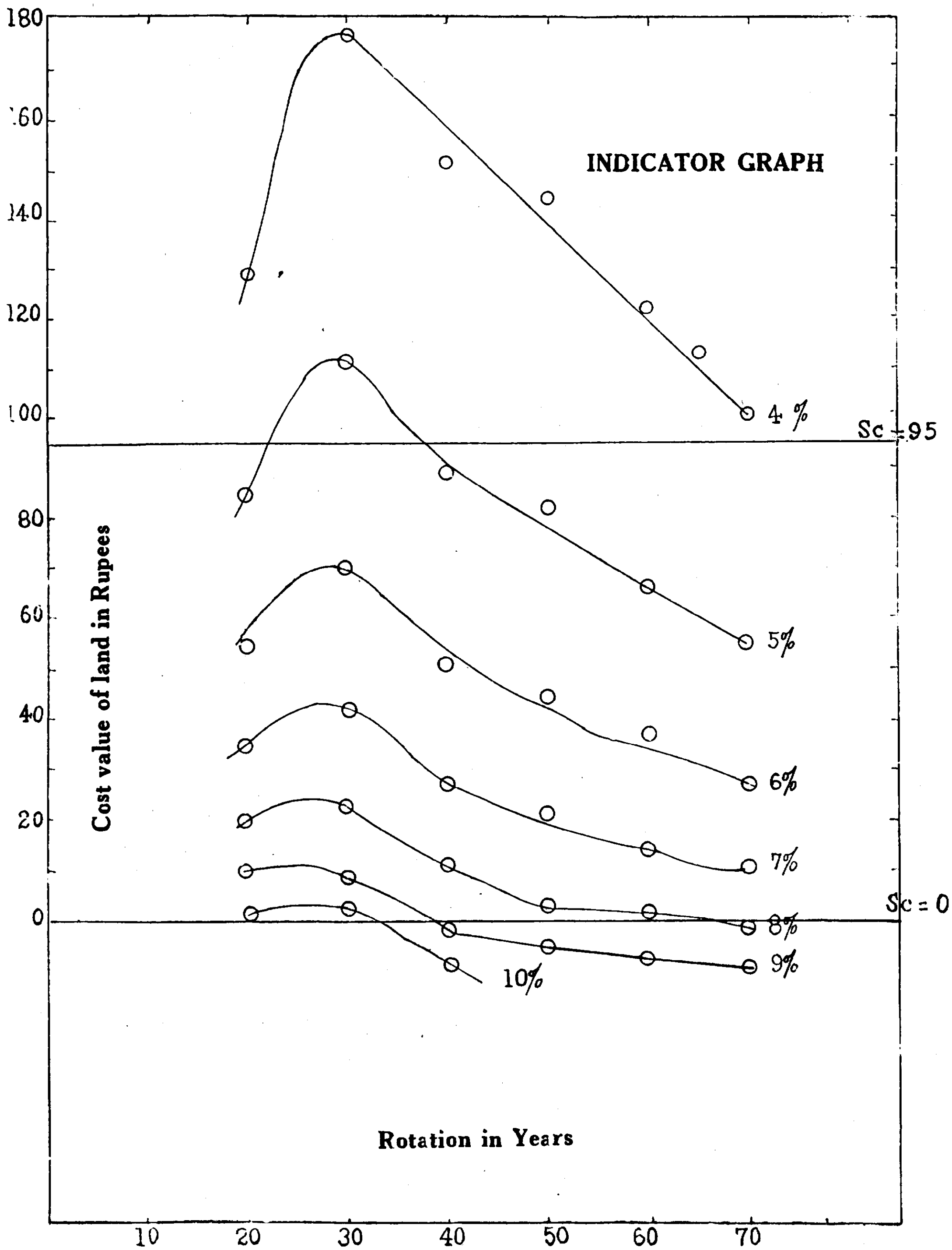
Financial Yield Table for Kyetpyugan Teak

Assuming p = 4 per cent. and Sc = 95/- per acre.

Rotation.	Net value of yields. Final.	Intermediate.	Sum of intermediate yields with interest at 4 per cent. to date.	Total yield to date.	Cost of formation 25/- with interest to date.	Cost of intermittent expenses with interest to date.	Cost of soil with interest to date.	6 + 7 + 7a.	5 — 8.	Annual costs with interest to date.	Profit, 9—10.	$\frac{1{\cdot}04^r-1}{{\cdot}04}$	Gross rental, 9/12.	Net rental, 13—1·25 annual costs.	Mean annual forest per cent.	Indicating per cent. during each period of 10 years.	Expectation value of the soil Se.
1	2	3	4	5	6	7	7a	8	9	10	11	12	13	14	15	16	17
(15)	..	25														Per cent	
(20)	218	40	30	248	54·8	3·3	113·2	171·3	77	37·2	40	29·8	2·58	1·33	4·7		128·6
30	450	145	104	554	81·1	4·9	213·1	299·1	255	70·1	185	56·1	4·54	3·29	5·2	5·8	177·5
40	450	130	369	819	120·0	7·2	361·0	488·2	331	118·8	212	95·0	3·48	2·23	5·0	2·6	150·8
50	520	100	738	1,258	177·7	10·7	580·1	768·5	489	190·8	298	152·6	3·21	1·96	4·8	1·9	143·8
60	500	30	1,241	1,741	263·0	15·8	904·3	1,186·1	555	297·5	257	238·0	2·33	1·08	4·5	1·8	122·0
65	500	..	1,547	2,047	320·0	19·2	1,119·8	1,459·0	588	368·7	219	294·9	2·00	0·75	4·1	1·2	113·4
70	460	..	1,882	2,342	389·3	23·4	1,384·3	1,797·0	545	455·3	90	364·2	1·50	0·25	4·1	..	101·2

Table No. 3. Se calculated for values of p from 5 per cent. to 10 per cent.

r.	Yr.	$\text{Tax}1.0p^{r\cdot a}$	$(c+y)1.0p^r$	2+3—4	$1.0p^r—1.$	5/6	$\frac{e}{.0p}$	Se.
1	2	3	4	5	6	7	8	9
			p = 5 per cent.					
20	218	31·9	70·3	179·6	1·653	108·6	25	83·6
30	450	117·1	114·5	452·6	3·322	136·2	25	111·2
40	450	427·0	186·5	690·5	6·040	114·3	25	89·3
50	520	907·2	303·9	1123·3	10·47	107·3	25	82·3
60	500	1641	495·0	1646·0	17·68	93·1	25	68·1
70	460	2722	806·3	2375·7	29·43	80·7	25	55·7
			p = 6 per cent.					
20	218	33·5	85·0	167	2·207	75·7	20·8	54·9
30	450	131·5	152·2	429	4·743	90·4	20·8	69·6
40	450	495·2	272·4	673	9·284	72·5	20·8	51·7
50	520	1119·6	488·1	1152	17·416	66·2	20·8	45·4
60	500	2184	874·0	1810	31·979	56·6	20·8	36·8
70	460	3964	1565	2859	58·057	49·3	20·8	28·5
			p = 7 per cent					
20	218	35·1	102·5	151	2·870	52·6	17·9	34·7
30	450	147·7	201·7	396	6·612	59·9	17·9	42·0
40	450	576·0	397·0	629	13·98	45·0	17·9	27·1
50	520	1382	780·0	1122	28·46	39·4	17·9	21·5
60	500	2929	1536	1893	56·95	33·2	17·9	15·3
70	460	5822	3021	3261	113·0	28·9	17·9	11·0
			p = 8 per cent					
20	218	36·7	123·5	131	3·661	35·8	15·6	20·2
30	450	166·0	266·7	349	9·070	38·5	15·6	22·9
40	450	671·0	575·7	545	20·73	26·3	15·6	10·7
50	520	1599	1243	876	45·90	19·1	16·6	3·5
60	500	3948	2683	1765	100·3	17·6	15·6	2·0
70	460	8590	5793	3257	217·6	15·0	15·6	—0·6
			p = 9 per cent					
20	218	38·4	148·5	108	4·60	23·5	13·9	9·6
30	450	185·7	351·7	284	12·26	23·2	13·9	9·3
40	450	783·0	832·2	401	30·41	13·2	13·9	—0·7
50	520	2161	1970	711	73·35	9·7	13·9	—4·2
60	500	5354	4665	1189	175·0	6·8	13·9	—7·1
70	460	12743	11040	2163	415·7	5·2	13·9	—8·7
			p = 10 per cent					
20	218	40·2	178·2	80	5·726	14·0	12·5	1·5
30	450	208·0	434·5	224	15·40	14·5	12·5	2·0
40	450	897·0	1199	148	44·26	3·1	12·5	—9·4


INDICATOR GRAPH
Cost value of land in Rupees
Rotation in Years
180
160
140
120
100
80
60
40
20
0
10
20
30
40
50
60
70
4 %
5%
6%
7%
8%
9%
10%
Sc = 95
Sc = 0

NOTE BY MR. D. J. ATKINSON, I.F.S.

Mr. Smythies' able criticism of my article is very welcome, and is, we may hope, only the precursor to further efforts on the part of others.

2. To answer, firstly, Mr. Smythies' criticism of my choice of $2\frac{1}{2}$ per cent. as "the normal rate of interest." I took this rate of interest mainly, I must admit, because it is the rate with which I was brought up. At the same time it is not at the present day so very wide of the mark, and is, I submit, possibly nearer to it, in the case of a soundly secured long-term investment, than Mr. Smythies' 4 per cent.—I think I am right in saying that even the Rangoon Corporation's recent loan, oversubscribed in a few hours, was at only 3 per cent., or at most $3\frac{1}{2}$ per cent. However, as I subscribe rather to the view expressed by Hiley ("Economics of Forestry," pp. 102—104), that the rate of interest applicable to forestry should be somewhat above that of gilt-edged securities, I am prepared to admit that $2\frac{1}{2}$ per cent. is low, though one hopes that, unless another world catastrophe eventuates, conditions will tend to approach my figure rather than Mr. Smythies'.

Mr. Smythies has shown, however, that in the particular case of Kyetpyugan and with the price rates used, the rate of interest applied has no effect on the financial rotation which at all rates lies at about 30 years. He agrees further that little sacrifice would be involved in increasing the actual rotation to 40 years. In point of fact the rotation for the next cycle has now been fixed at 50 years and regeneration has commenced on that basis, the argument used, which we hope future experience will substantiate, being that with proper tending the quality of the new crop will show an improvement on that of the old, particularly amongst the later thinnings and final yield, and that in consequence the price rates used in the present calculation will require revision upwards.

3. Mr. Smythies has indicated another method of considering the general question of the financial attractiveness of forestry, that is, by ascertaining the expectation value of the soil at the various rotations and rates of interest. This is a very valuable method for showing the relative attractiveness of the various alternatives, teak, paddy, or fruit crops, open to the owners of the land, here the Government, and, as Mr. Smythies points out, leads to the important

conclusion that, under conditions such as those of Kyetpyugan, "the prospects of profit to Government are greater under forestry than under rice cultivation," and, he might have added, than under garden cultivation.

He has shown that, again under Kyetpyugan conditions, it would pay the owners of the land to grow teak on a rotation of 30 years in preference to any other method of cultivation which produced less than an annual rental of 7/-, assuming, that is, that a return of 4 per cent. compound interest were desired. Should the owner be content with 2½ per cent. the land would carry an expectation value of 388/-, requiring an annual rental of nearly 10/- (9.7) from other forms of cultivation to better it.

4. When, however, Mr. Smythies uses his expectation values (Se) for the purpose of calculating his financial yields (or mean annual forest per cent.) I quarrel with him, as I consider that the method involves an inherent absurdity. I quote from his para. 6, "In order to calculate the mean annual forest per cent. equation No. 1

$$\left(Se = \frac{Yr - \Sigma\ Ta \times 1{\cdot}op^{r} - 1 - c \times 1{\cdot}op^{r}}{1{\cdot}op^{r} - 1} - E\right) \text{ was solved}$$

by taking a set of values for p (4, 5, 6, 7, 8, 9 and 10 per cent.) and calculating Se for the different rotations from 20 to 70 years for each value of p. The results are given in Table No. 3. An indicator graph was then prepared by plotting Sc against r . . . . . ." The results he had obtained were for Se, which he has had to assume equal to Sc in order to be able to draw his indicator graph. The difference between Se and Sc being a measure of the profit of the undertaking, the two can be equal only when the profit is nil and the return from the investment exactly equal to the rate of interest at which the calculations have been made. On this assumption, therefore, but only on this assumption, it is legitimate to claim that the financial yields have been earned as shown in column 15 of Table 2 by a capital (Sc) of 95/-. But column 11 of the same Table shows that a profit *has* been earned at all rotations, which forms an addition to the financial yield, of which no account is taken in column 15. The virtual yield, therefore, is greater than the nominal yield shown

in column 15 by a per cent. equivalent to the profit shown in column 11 earned on a capital of 95/-.

I therefore consider the old formula used in my previous note, and which can also be written mean pf $= \frac{Se \times \cdot op}{Sc} \times 100$ gives a truer indication of the virtual financial yield than the present method of indicator graphs, and I regret to see that in Schlich's 5th edition it receives but passing mention (p. 142). In this formula the true value of Sc receives consideration, and there is no necessity to assume Sc equal to Se—in fact, as is immediately apparent from the formula as written above, this can be so only when mean of pf = p.

The absurdity I see in the method of indicator graphs is contained in the fact that it permits a financial yield to be evaluated on a capital of O, which is inherently impossible. The introduction of O as a value for Sc into either of the equations referred to above results in a *reductio ad absurdum*. As Hiley says (p. 110): "Landowners and Governments frequently plant land which is already in their possession. In such cases the value of S should be the market price of the land with additions for cleaning and draining."

The financial yields which I suggest, therefore, are really earned under Kyetpyugan conditions, and on a soil cost value of 95/- and interest of 4 per cent. are the following:

Years.		Per cent.
20	...	5.4
30	...	7.5
40	...	6.3
50	...	6.1
60	...	5.1
65	...	4.8
70	...	4.3

rather than the rates shown in column 15 of Mr. Smythies' Table No. 2.

5. I should like to take this opportunity of correcting a misapprehension that has arisen from a somewhat slovenly use of words in my Note on the Financial Possibilities of Plantations. In para. 6 of that Note the following passage appears:

"Given a knowledge of costs, and of prices obtainable for the various yields, a financial yield table can, of course, be prepared for any plantation, and the financial rotation

> thus calculated. The writer, however, with some diffidence puts forward the following as a much simpler method of arriving at the same result, or at least of indicating the age beyond which a given stock should *not* remain on the ground."

It should not, of course, have been allowed to appear that a claim was being made that the age-volume curves there referred to indicated the financial rotations for the various quality classes of teak. The claim lay in the final part of the sentence quoted. It is apparent that these curves cannot indicate the financial rotation, which has to be worked out on the particular conditions, price rates, etc., pertaining to the plantation concerned. In fact, in the case there referred to, that of Kyetpyugan, the figures given showed the financial rotation as falling about the year 30, while the curve for Class III indicates 50 as the age beyond which this quality class should not remain on the ground.

The suggestion I wished to convey was that in no case can it be *financially* justifiable to maintain Class III teak beyond the age of 50, or Class II beyond about 70 though the actual financial rotations *may* be much shorter than these ages, which are to be taken as maxima. Where the fact that "the culmination of expectation values occurs earlier in the better quality classes" (Schlich, p. 156) seems to conflict with this argument, I suggest the explanation is that, under conditions which necessitate the financial rotation of Class I timbers being fixed beyond the culmination point of Class III, it would not be financially justifiable to grow this latter class at all, and at no age could it result in anything but a loss.

STATE CONTROL OVER PRIVATE FORESTS IN FINLAND

By J. N. Sinha, Bihar Forest Service

Private forests in Finland are subject to systematic control and supervision by the State. A private forest owner is not allowed to deal with his forest as he may like. The implications of ownership are restricted by a "Law Concerning Private Forests" first passed in 1917 and revised in 1928. The object of this law is stated in Section 1 thereof: "Forest may not be devastated, and forest may therefore not

be felled in such a manner, nor the ground be left in such a state after felling or be treated in such a way that the natural regeneration of the forest is thereby jeopardised." The Forest Department of Finland has a special "Private Forest Supervision Section."

2. *Central Forestry Association.*—At the head of the executive is a Central Forestry Association composed very largely of non-official members. Its function is to formulate directions, collect statistics and co-ordinate the activities of the District Forestry Boards mentioned hereafter. The necessary funds are supplied by the State.

3. *District Forestry Board.*—Finland is divided into 18 forest districts. In every district there is an organisation known as the District Forestry Board. It is composed of three to five members one of whom is appointed by the Government and the rest by the local agricultural association. There are as many deputies appointed similarly. All these members are experienced in forestry and well acquainted with the local conditions. They hold office for three calendar years. They receive no pay but are given certain allowances for every meeting attended and travelling expenses. There are about 20 meetings in the year.

4. Every District Forestry Board is bound by law to employ at least one University-trained Forest Officer (designated locally as Forester) and the necessary number of Rangers who have received two years' training at the forestry school. Some Boards employ several foresters so that the average per Board is three. The head forester is in charge of the office and books of the Board, controls and supervises the activities of the subordinate staff and in all matters concerning the private forests of the district tenders expert advice to the Board.

5. The function of a District Forestry Board is twofold:

(1) To enforce the private forest law;

(2) To carry out propaganda in favour of forestry and to spread knowledge and help farmers in sound management of their forests.

6. It is the duty of the executive staff of the Board to go about continuously and see that the law is observed by all forest owners. Should a breach of law be discovered, the forester takes with him two members of the Communal Forestry Board (described hereafter) and draws up an inspection report and submits it to the District Forestry

Board with his opinion and suggestions. If the Board agrees that devastation of forest has been caused it has power, conferred by law, to order the temporary closing of the forest or part thereof as may be silviculturally necessary. The owner is asked to enter into an agreement by which he binds himself to observe the closure and to carry out sowing and planting or other works of improvement necessary to restore the forest to its former state of productivity. Should the owner fail to enter into such an agreement the case is submitted to a court of law, which realises from the owner the estimated cost of the works to be done and places it at the disposal of the Board. The owner may appeal against the order of the court but its judgment is carried into effect meanwhile. In practice cases have rarely to be sent up to court.

7. Sections 7 to 11 of the Private Forest Law lay down that if any forest owner sells trees for felling the purchaser is bound to give written notice to the Communal Forestry Board before felling is begun of the felling site, the extent, nature and time of felling, etc. The Communal Board of Forestry forwards the notice to the District Board. In this way there may be no extensive cutting of trees without the cognisance of the District Forestry Board. If the latter suspects that the notified felling is in contravention of the law it orders an inspection. If the inspection confirms that forest has been devastated punitive measures as described above are taken. In this law there appears a point of weakness. The purchaser is not bound to wait after giving the notice, so that by the time the District Board are aware of it damage may have been done. It cannot prevent, only repair it. If the purchasers were bound to wait for a certain length of time the Board might have an opportunity to prevent damage. I discussed this point with the local forest officers and they agreed that it *was* a weak point which would probably be remedied at the next legislation.

8. The second part of the Board's function is still more important. The people have become greatly forest-minded, so breaches of the law are few. For example, in the South-West district (headquarters at Turku) where there are three foresters and six rangers, out of 1,789 total working days last year, 1,293 were spent in works of improvement and development and only 496 days in dealing with breaches of the law. The development work consists of giving

lectures in agricultural and other schools, organising exhibitions, issuing pamphlets of information and propaganda, delivering public lectures, etc. They maintain nurseries and supply seedlings to farmers. The services of foresters and rangers may be utilised by any farmer for purposes of guidance in marking trees for felling or carrying out plantations, etc., on payment of certain fees per day of service. A ranger's fee, for instance, is 40 Finnish Markkaa (or Rs. 2-8) per day for planting work and Rs. 5 to Rs. 6 for marking or estimating.

9. Funds for the expenses of the District Forestry Boards are provided by the Government. They have also a small income of their own from sale of seed, seedlings, literature, services of foresters and rangers, etc. In 1934 the Government grant amounted to Rs. 4 lakhs. The Government of Finland have further decided to spend not less than 17½ million Markkaa (about Rs. 10 lakhs) annually, starting from 1938, for the promotion of private forestry. The fund is to be utilised for granting loans for works of forest improvement to farmers at a low rate of interest or free grant in cash or providing free seed and seedlings and free service of trained staff, etc.

10. Instructions for the District Forestry Boards are drawn up by the Government. The Boards are under the control of the Forest Department, but the control extends to the utilisation of funds and observance of the law and regulations only. For the rest the Boards are left with a free hand to deal with their own matters as they may think best. The Central Forestry Association has little executive powers of interference with the activities of the Boards. The organisation for the control of private forests is thus mainly in the hands of the farmers themselves.

11. *Communal Forestry Board.*—To assist the District Forestry Board every Commune appoints a Communal Forestry Board, consisting of not less than three members and as many deputies from among the resident farmers experienced in forestry. Instructions to regulate the activities of the Communal Forestry Boards are drawn up by the Commune and approved by the Governor of the Province. The Commune bears all the cost. The Communal Board's main duties are the following:

(a) To collect notices of felling (*vide* para. 7) and forward them to the District Forestry Board concerned.

(b) To assist foresters or rangers deputed by District Boards for inspection.

12. *Local Forestry Associations.*—In addition to the District and Communal Boards there are Local Forestry Associations. A number of local forest owners combine and employ one or more forester or ranger whose services they utilise generally for looking after their forests and, in turns, for specific work like marking, planting, etc. The members of the association pay 1 Mark (one anna) per hectare ($2\frac{1}{2}$ acres) of their forest per year and in addition certain fees for special services of the forester or ranger. About 5,000 to 6,000 hectares employ one forester and two to three rangers. Associations having 20,000 hectares employ one forester and two to three rangers. The operation of Local Forestry Associations does not in any way detract from the jurisdiction or powers of the District Forestry Board. The local association is a good means of providing expert advice on forestry to small farmers who cannot afford individually to employ trained staff. The services of the staff of the District Board are, of course, available to all, but the strength of the staff is never sufficient to do all that may be asked for. The staff of the local associations in addition know the local conditions more thoroughly and are in a position to render better and more ready services. The Government helps these local associations with funds in deserving cases.

13. The above scheme of organisation for the control of private forestry is working very effectively in Finland. Even small farms look neat and well managed. We were told that the yield from private forests had appreciably increased since the introduction of control. To take one example, the yield from Manttä Company's forest rose from 17 to 28 cubic metres per acre from 1920 and they expect 33 in future.

14. For general information the following is appended:

The total land area of Finland is 34.5 million hectares (or about 135,000 square miles). The area covered with forest is 25 million hectares, or about 100,000 square miles or 73.5 per cent. of the total land area.

The ownership of forest is distributed as follows:

		Per cent.
Private	...	50.9
State	...	39.8
Companies	...	7.6
Church	...	1.0
Communities	...	0.7

Spruce and pine are the principal trees. Logs are floated down rivers and lakes to the saw mills and pulp factories. There is very little wastage as the pulp factories consume all sizes.

In 1934 the gross revenue of the Forest Department was rupees 1½ crores and expenditure 85 lakhs.

Forestry is a very important subject in Finland. As much as 85 per cent. of the total value of exports is made up by forest produce. The Director-General of Forestry is also Prime Minister of Finland.

LOIMAA, FINLAND,
5th August 1937.

CROWN RATIO IN INDIAN CONIFERS.

BY R. MACLAGAN GORRIE, D.SC.

Summary : - A résumé is given of recent Australian work on the use of the crown ratio as a guide to spacing in thinnings. Its application to Himalayan conifer crops is discussed.

An article entitled "Crown Ratio," by C. E. Lane-Poole, appeared in *Australian Forestry* for December 1936 (Vol. I, No. 2), and it brought out some interesting facts. As that article is unlikely to reach many Indian foresters, owing to an unfortunate shyness amongst provincial organisations about subscribing to colonial forestry periodicals, a résumé is given below:—

The term "crown ratio" is the mathematical relationship between *diameter* at breast height and *crown-spread* expressed as the average width of the crown. Duchaufour gave this ratio as 16 for beech in Compiègne and used this figure to calculate the area covered by dominant trees. That is to say, for every tree of 20 in. diameter he allowed a crown width of 26 ft. 8 in.; for every tree of 30 in. diameter, a crown width of 40 ft., and so on. Attempts have since been made to use such ratios in estimating the growing stock from aerial photographs.

The eucalypts as a whole are very intolerant of any suppression so that it is essential to let them have room for individual development. Lane-Poole gives 18 as the ratio for a number of eucalyptus in a variety of diameter classes up to 30 in., and shows

that the change in the number of trees per acre varies inversely with the crown-spread, *e.g.*—

D. B. H.	*Crown-spread.*	*Area of crown.*	*No. of stems per acre.*
Inches.	Yards.	Square yards.	
1	½	¼	19,360
4	2	4	1,210
5	2½	6¼	774
8	4	16	302
20	10	100	48
30	15	225	21

He advocates the use of such reduction tables as a guide to thinning, and gives two examples which have apparently been accepted for local thinning practice in Australia, one based on a ratio of 18 for most gum species, and one for spotted gum (*Eucalyptus maculata*) which requires an even larger ratio of 18.7.

How does all this help us in our thinnings? It is very doubtful if any of our conifer crops approach such complete regularity that any spacing table can be used as the *primary means of control* in markings, but each additional check we can get upon the results of "thinning by eye" is of undoubted value; and a consideration of the local ratios for various ages of crop should help foresters to appreciate the importance of crown space in relation to diameter increment and so improve our thinning technique. Taking the yield table data for our three common conifers of comparable quality, each shows a gradual and more or less similar drop in the crown ratio between the ages of 30 and 120, as is shown in the following table (A). But the yield tables themselves do not give a true picture of the relative crown value of these three species, as has already been pointed out in a recent paper ("Single Tree Silviculture in Indian Conifers," p. 653. *Indian Forester,* October 1937), for there is not such a large difference in the typical crown development of chir pine and blue pine as is indicated by the yield table stocking of 50 per acre for chir against 130 per acre for blue pine for Quality 2 maturing crops. Taking 70 stems per acre as a fair stocking for both species at an age of 120, or just prior to the seeding felling stage, the ratio should be about 15 for both species instead of 17 for chir (with 50 stems per acre) and 11½ for kail (with 130 per acre).

TABLE A.

Crown Ratio Studies.

Age.	*Pinus excelsa*—blue pine—Quality II.			*Pinus longifolia*—chir—Quality II.			*Cedrus deodara*—deodar—Quality II III—C grade.		
	Diameter.	Space. Ins.	Ratio.	Diameter.	Space. Ins.	Ratio.	Diameter.	Space. Ins.	Ratio.
20 ..	2·6	72	*30	1·6	66	*41	1·9	52	*38
30 ..	5·1	102	19	4·3	90	21	3·6	58	16½
40 ..	7·5	126	17	7·0	132	19	5·3	88	16½
50 ..	10·0	144	14½	9·3	168	18	6·9	98	14½
60 ..	12·4	156	12½	11·6	219	18	8·4	108	13
70 ..	14·8	180	12	14·0	252	18	9·6	120	12½
80 ..	16·8	204	12	16·3	..	18	10·8	133	12½
90 ..	18·2	..	12	18·5	318	17	11·7	138	12
100 ..	19·2	222	12	20·5	354	17	12·7	144	11½
110 ..	19·9	..	12	22·2	..	17	13·6	162	11½
120 ..	20·4	234	11½	23·2	..	17	14·6	168	11½
	20·4 @ 70 p.a.	324	16	23·2 @ 70 p.a.	324	14	14·6 @ 114 p.a.	252	15

*By thinning all three species to 6×6 at 6′ high this automatically short-circuits the Yield Tables' high ratios and keeps all of them below 30 by eliminating masses of suppressed material.

TABLE B.

Crown Ratios in Deodar: Comparison of Thinning Grades.

Age.	Quality 2/3.						Quality 1.					
	C grade.			*E grade.*			*C grade.*			*E grade.*		
	Diameter.	Space.	Ratio.	Diameter.	Space.	Ratio.	Diameter.	Space.	Ratio.	Diameter.	Space.	Ratio.
10 ..	..	..	..	..	..	..	1·3	42	55	1·6	50	31
20 ..	1·9	52	38	2·3	54	23½	3·9	66	17	4·8	96	20
30 ..	3·6	58	16½	4·3	84	20	6·6	100	15	7·9	135	17
40 ..	5·3	88	16½	6·3	114	18	9·2	123	13½	10·9	189	17
50 ..	6·9	98	14½	8·2	138	16	11·5	138	12	13·5	210	15½
60 ..	8·4	108	13	9·9	168	16	13·5	165	12	15·9	234	15
70 ..	9·6	120	12½	11·4	186	16	15·3	180	12	17·8	252	14
80 ..	10·8	133	12½	12·5	201	16	16·8	186	11	19·4	276	14
90 ..	11·7	138	12	13·6	204	15	18·2	195	11	20·9	282	13½
100 ..	12·7	144	11½	14·6	210	15	19·5	204	10½	22·2	294	13½
110 ..	13·6	162	11½	15·7	222	14	20·7	210	10	23·5	318	13
120 ..	14·6	168	11½	16·7	234	14	21·9	222	10	24·8	324	13
130 ..	15·6	174	11½	17·7	246	14	23·1	234	10	26·1	336	13
140 ..	16·5	180	11½	18·8	252	13½	24·3	240	10	27·4	354	13

Observations on Mr. Laurie's Note :

There is actually so little difference between the "crown ratio" and the "available growing space ratio" as defined by Mr. Laurie that the simpler term, though slightly less accurate, fulfils the purposes of my article, which are :—

(1) To report forestry developments from abroad,

(2) to get foresters to think more about their thinnings, and

(3) to show that the yield tables for our 3 coniferous crops do not give a true picture of the relative requirements of these species or of their density of stocking as occurring in our forests today.—R.M.G.

Deodar of the same age and quality is shown in the Multiple Yield Tables as having a much larger number of trees and a smaller diameter, so that this also has a small ratio of 11½ throughout the latter half of its life. In practice, stocking in the latter half of the deodar rotation is very seldom as dense as is indicated by the Tables, and for an age of 120 and Quality 2/3 the E grade stocking is probably most common and is certainly preferable because of its encouragement of diameter increment. This would give ratios respectively of 11½ and 14:

Grade.	*Diameter.*	*Space.*	*No./acre.*	*Crown ratio.*
C	14.6	168	256	11½
E	16.7	234	133	14

It would, therefore, appear that for maturing crops in the latter half of their rotation we should aim at a ratio of 14 for deodar and 15 for chir and blue pine.

In considering younger crops, it is apparent from the extracts from Yield Tables shown below (Table B) that the ratio is higher for young crops than for old ones, though when it comes to anything below the age of 40 the ratio figures fluctuate so much that they may not be of much value as a criterion for spacing. This, however, is a very tentative conclusion, and it would be interesting to have others' views when this possibly useful method of checking current thinning intensities has been given a trial in the field.

NOTE ON "CROWN RATIO IN INDIAN CONIFERS"

BY M. V. LAURIE, I.F.S.

What Dr. Gorrie calls "crown ratio" is not true "crown ratio" but what might be termed "available growing space ratio." "Crown ratio," properly speaking, is the ratio of the mean diameter of the crown to the D. B. H. of the stem. If applied to a crop it would be the average diameter of all the crowns in the crop divided by the mean D.B.H. of the stems.

Dr. Gorrie has assumed that all crowns are evenly and regularly arranged and that they all touch each other, and on this basis he calculates "crown ratio" by finding the area per stem from the yield table and, assuming square spacing, calculating the side of the square of this area, calling this the crown diameter and dividing it by the D.B.H. The resulting figure is, of course, not the true crown diameter at all, but a ratio based on the available growing space per tree. In practice it would be larger than the true crown ratio, and would bear a varying relationship with it at different ages of the crop and at different stages of closure after thinnings.

Dr. Gorrie asks whether this ratio could not be used as an additional check on thinning grades. I fail to see how this would be possible for the following reasons:

(*a*) The crown development of the trees in a crop at the time of thinning is the result of previous thinnings. No measurement of crown ratios will give you any check on the thinning you are just doing. By removing the smaller and more dominated trees you might alter the crown ratio very slightly, but since one of the features of crown ratio is supposed to be its constancy for different diameters in the same crop, the change is not likely to be sufficient to give any measure of thinning intensity.

(*b*) Crown ratio will not vary sufficiently greatly between plots thinned regularly by different grades to enable the figure to be used as an estimate of thinning grade. For instance, Dr. Gorrie gives "tree-space ratios" of 12 and 15 respectively for C grade and E grade thinnings for deodar II/III quality 90 years old. True "crown ratios" will probably be even less different, but quite apart from that, the difference is too small to make its application to a single

plot of any significance, though it may be sufficiently large to give consistent results when deduced from and applied to yield table figures derived from thousands of measurements.

As a rough guide to thinning, some idea of the crown space that should be given to a tree of a given diameter under given conditions might be useful, but the measurement of crown ratio will not help much in this, as the tendency after thinning to different espacements is for the trees to respond differently and ultimately get back to somewhere near the same crown ratio irrespective of the thinning intensity.

In all comparative thinning research, crown studies should find a place, and provision has been made for this in a number of recently laid out thinning plots. For control purposes, however, there is no advantage in using a rather indeterminate quantity like crown ratio in preference to the much simpler and more definite quantities such as number of stems per acre, basal area, or, best of all, number of stems per acre for a given mean diameter as a criterion of intensity of thinning. We have now got yield tables for all the most important hill conifers as standards with which to compare the above quantities.

From a purely theoretical standpoint, it seems unlikely that Lane-Poole's crown ratio theory for eucalypts in Australia will apply to hill conifers on account of the fundamentally different nature of the crops. The data on which Lane-Poole bases his theory that the ratio between diameter and crown-spread of a given species throughout its life in a given stand is constant, appear to have been derived from stands of eucalypts treated on a system of heavy thinnings based on Craib's conception that the competition for soil moisture rather than for light is the main factor limiting the growth of intolerant species. This heavy frequent thinning regime in the early part of the rotation, always anticipating competition and never allowing any suppression, results in the maintenance of practically only one crown class, namely the dominant trees. Comparatively speaking, the hill conifers are far more tolerant than eucalypts. Competition for light comes into play more vigorously than competition underground and an entirely different thinning regime, with a correspondingly different distribution of crown classes is the result. We have no data to show what the behaviour of crown ratio in such crops is likely to be, but it is almost certain to be different from the simpler case of the eucalypts.

FORESTS AND MAN

TEXT OF TALK BROADCAST BY E. A. GARLAND, I.F.S.

Abstract.—Talk broadcast from Bombay (V. U. B) on 25th July 1937 describing the effects of forests on the formation of man's philosophies and religions through the ages, the assistance which wood has been to man in the development of his civilisation, and the life led by a forest officer in India.

The trouble with any specialist talking on his own subject is to avoid being tediously technical. In dealing with forests and forestry I might start by telling you that "a forest is an exceedingly complex biological unit. It comprises not only a more or less diversified aggregation of trees, but numerous species of shrubby and herbaceous plants, fungi, insects, herbivorous animals and a complex soil fauna and flora. In other words it consists of a very large number of mutually interacting organisms which are affected by, and themselves affect, complex of environmental factors." Now that is an excellent technical definition of a forest, but I very much doubt whether, as a statement, you find it either interesting or illuminating. What I want to try and present to you is the forest as a fascinating and important part of the country. Fascinating because it is least susceptible to being tamed and controlled by man: important because when controlled and disciplined it becomes a valuable—and even an essential—asset. Moreover, it occupies a special place in country life and all that life in the country represents. I believe that country life has a very definite message for the townsman. An American novelist, Andrew Lytle, has expressed this belief in an introductory letter to his recent novel "The Long Night:" "It is not only that in a healthy country society man finds himself in his right relation to nature. It is, more explicitly, that neither man nor the arts can long flourish after country loses its vigour, for this vigour sustains in one way or another all the social practices, making it possible for the town to intensify, give form and expression to the common life." In India the countryman is seldom vocal and it is for this reason that I am trying to tell you to-night something of that part of the country life of India which I know best, and which plays an important and often essential part in rural economics—the forests.

Man's attitude to forests has always been a peculiar mixture of antipathy and attraction, awe and admiration. From the beginning of time man has fought against the forest to keep it from invading his

fields. He has cut it down in order to sow his corn: burnt it to drive away the wild beasts which it harboured and which preyed on his family, his cattle and his crops. Yet all the time he has felt the fascination and the mystery of the forest; so inscrutable, so apparently inanimate; yet intensely alive and rhythmic; growing silently, inevitably; passing from youth to age and back to youth again; teeming also with life in innumerable forms, beast and bird, butterfly and beetle. In consequence man has very frequently linked the forest with his gods and sacred groves have played important parts in many of the earlier religions. There are also innumerable legends and folk stories dealing with the mysteries supposed to take place in forest and wood. In these tales the trees are often endowed with human characteristics, the power to speak and feel, and man or maid is imagined as imprisoned within a tree through the power of witchcraft. Nor has this influence of trees on man been felt and recorded only in ancient fables. It has been powerful through all the centuries. Here, for instance, is the poet Henley writing in the 19th century:

> Not to the staring Day—
> For all the importunate questionings he pursues
> In his big, violent voice—
> Shall those mild things of bulk and multitude,
> The trees—God's sentinels . . .
> Yield of their huge unutterable selves.
> * * * * *
> But at the word
> Of the ancient sacerdotal Night,
> Night of the many secrets, whose effect—
> Transfiguring, hierophantic, dread—
> Themselves alone may fully apprehend,
> They tremble and are changed:
> In each the uncouth, individual soul
> Looms forth and glooms
> Essential, and, their bodily presences
> Touched with inordinate significance,
> Wearing the darkness like a livery
> Of some mysterious and tremendous guild,
> They brood—they menace—they appal.

Then too there is the very modern product of the ancient culture of China, Lin Yutang, writing in his book "My People and My Country," and recording his reactions to a single tree in some pleasant landscape rather than to the dense mass of a forest: "The

outline of every tree expresses a rhythm resulting from certain organic impulses; the impulse to grow and reach out toward the sunshine, the impulse to maintain its equilibrium, and the necessity of resisting the movement of the wind. Every tree is beautiful because it suggests these impulses, and particularly because it suggests a movement towards somewhere, a stretching toward something. It has not tried to be beautiful. It has only wanted to live. Yet the result is something perfectly harmonious and immensely satisfying." So, for untold centuries, forests and trees have influenced thinking man in the formation of his philosophies and this influence is to-day a part of our heredity and of our heritage.

Turning now to the more practical side of man's contacts with the forests, although the cultivator must always have been at war with the forest to some extent, yet, somewhat paradoxically, wood produced in the forest has been since the beginning of time a principal aid to man in his development. With all the discoveries and developments of our civilisation wood is still of immense importance for hundreds of purposes. For primitive man it was essential. Indeed it may be no exaggeration to say that without wood man might still be on a level with the beasts. Wood gave him the fuel for his hearth. Wood made his first clubs for protection against his enemies. Leaves and fibres formed his first garments and wood made his primitive agricultural instruments. Later, wood formed the framework for houses; wood built the bridges and boats which enabled man to move in safety over water; wood built the carts in which men travelled, the chariots in which they went to war. All through the ages skill in the use of wood has marked the various civilisations. Remains are still in existence of the ships, chariots and furniture made during the early Egyptian civilisation about 2500 B.C. Solomon built his temple at Jerusalem out of the cedars from Lebanon long before the Christian era and probably imported shisham wood from India. The cunning construction of their long bows of yew made the English archers the most formidable military force in Europe in the 12th century. English oak and Indian teak built the ships—"the wooden walls of England"—without which the British Empire would never have been founded.

In this amazing modern world in which we live to-day, wood still takes a very important place. Iron and steel, cement and

concrete may have displaced it from some of its traditional uses for constructional purposes, but, almost daily, new uses are being developed by scientists who increasingly realise the possibilities which wood offers as a chemical raw material. Converted into cellulose and filaments it can already replace silk, wool and cotton. And now certain prominent scientists are already visualising the time when all man's requirements for food—for himself as well as for his beasts—will be obtainable from wood. Even as a forester I find that a rather dreary prospect! Yet, if such a development should ever occur and forests replaced field crops, the cycle of evolution would indeed be complete. Meanwhile, there are many less drastic changes in the traditional uses of wood. As an instance, plywood is a method of utilising timber which has increased enormously in popularity in recent years and has often been considered to be a quite modern invention. In point of fact, parts of a wooden coffin have recently been found made of 6-ply wood from cypress, juniper and pine by craftsmen in ancient Egypt, sometime between 2980 B.C. and 2475 B.C., that is, roughly, 4,000 years ago! Man is seldom as clever as he thinks he is!

For whatever purpose it may ultimately be required wood must first be grown in a forest, and it is really rather peculiar that the methods of production of wood, this material which has been so useful to man in all the stages of his development, have received so comparatively little attention. Man has apparently always been inclined to consider cheerfully that, like Topsy, "it just growed." Well the primeval forest did. But subsequently it has been all too easy to convert that same forest into a valueless tangle of useless weeds. (There are weed trees just as there are weed plants.) On the other hand to produce a crop of maximum value in the minimum of time is a highly specialised job requiring very technical treatment. And the greatest difficulty about a crop of trees is that it takes so long to get ready for the market. Have you ever thought that the piece of teak which went to make the chair in which you are now sitting probably required 100 or even 150 years to grow before it was ready to be marketed? It is just that fact of the time factor probably which has led to so much neglect in the past of the potentialities in developing the forests of the world to their fullest capacity. Man has always been in too much of a hurry. It requires considerable

faith in the future for a man to sow to-day something which cannot be reaped until long after he, his son and perhaps even his grandson, can have any interest in its produce. It is just for that difficulty and for that need for faith, as well as for the economic advantages, that the possession of forests can be of such immense value to a nation to-day, when the whole tempo of life tends to get faster and faster. To quote A. P. Herbert: "As Mr. Haddock said, what civilisation needs is a lot more things that can't be done quickly." I can imagine no better penance for a swindling "get-rich-quick" financier, or for a dishonest, self-seeking politician than a good long spell of penal servitude as a forest officer.

There is a popular idea that the life of a forest officer in India consists of little except the slaughtering of a succession of tigers and panthers. In real life he is the manager of a far-flung estate, usually situated in the most unhealthy localities. For a large part of each year he leads a lonely life, in conditions often of considerable discomfort and frequently in disheartening circumstances. Imagine yourself having sown, planted and tended a young crop of trees against failures of the monsoon and attacks by such pests as cockroaches and monkeys which ruin the young plants, until, finally, it has reached a successful juvenile stage about 4 or 5 years old. Wouldn't you be rather discouraged to hear that a herd of elephants had decided to use it as a dormitory? Or worse still if, at a later stage, say 10 or 20 years of age, when the full promise of the future crop was just beginning to become apparent, imagine your feelings on hearing that some careless, or possibly malicious, villager had set fire to it. No, a forest officer's life is not all picnics and *shikar,* though certainly he has unrivalled opportunities for such amusements when work does not call too insistently. As for hair-raising adventures these are probably as rare as in most other professions and, speaking generally, there are few events outstanding from the "long littleness—or large untidiness—of life." A forester's first duty is to maintain and improve the fertility of the soils on his estate; his second to convert that fertility into the most remunerative crops. A tree grows each year and the increment so put on to innumerable trees is the income which can be converted into cash. But, since it is impracticable to peel off each year's growth from each tree, capital and interest are indistinguishable to the layman and require very careful watching

even by the expert. Unless this vigilant watch is maintained, capital may be spent as income or may be badly invested. So forest officers have not only to be active managers out-of-doors but also shrewd trustees in the office as well. It is an intensely interesting job and it deals intimately with many more aspects of life and economics than I have had time to touch on now. Best of all it deals with the land and the produce of the land and gives to all who follow it faithfully that "right relation to nature" which breeds a measure of contentment and enjoyment in living which is simultaneously placid and yet active: an attitude of mind, which, for me, was well expressed in a poem by Marion Peacock published recently in *Country Life*:

Like green Venetian glass,
Tender and cold and clear,
A wood-pecker throws his laugh
For the wood to hear.
Long ago, when people loved to walk in the wood,
They heard
Something divine
Laugh in the laugh of the bird.
Time was not precious then,
One laid one's cheek to the flowers
And made a child of oneself in the wood
For hours . . . .
Out of the throat of the trees,
Snapping the silence in half,
Finding the slant of the rain
Comes the bird's laugh.
Enough if it make a frame
For this world grown old and seer,
Giving it outlines of gold
For one unquenchable hour.

BRUSH TREATMENTS WITH WOOD PRESERVATIVES

Abstract.—The best method of applying brush treatments with wood preservatives is described along with the limitations of this process.

One often reads in the advertising literature of proprietary wood preservatives that these preservatives have the miraculous property of penetrating wood to considerable depth if they are brushed on to the surface of the wood. The truth is of course that no preservative when brushed on to the surface of wood can penetrate to more than a fraction of an inch below the wood surface. Even if hot creosote is used, the penetration will usually be less than one-sixteenth of an inch.

Brush treatments therefore are purely superficial treatments, and as such are of very limited efficiency.

If the wood is thoroughly dry and sound before the application of the preservative and *if the brush treatment is repeated at regular intervals,* such treatment is fairly effective, *provided the periodical treatments reach every part of the wood surface.* This last proviso, however, is not always easy to accomplish in practice, as the wood has, since the first treatment, usually been inserted in the ground (as in the case of posts, poles, house-posts, etc.) or has been joined to other wood (as in roof timbers, beams, window-frames, etc.). In such cases it is obviously impossible to reach every part of the original wood surface with the preservative, and as it is those parts which are inserted in the ground or into walls or are joined to other wood members, which are the most vulnerable, periodic brush treatments in such cases cannot be effective and are of very restricted value. Unfortunately a brush treatment is the easiest type of treatment for the ordinary layman, and he does not usually look with favour on soaking or pressure treatments which entail extra trouble and expenditure on tanks or other apparatus. It is fairly certain therefore that the habit of brush-treating wood with preservatives will continue, and it must be admitted that a certain mental satisfaction is attained when one has painted some woodwork with an expensive proprietary preservative with potent names like "Mortant," "Antirot," or "Kiricide."

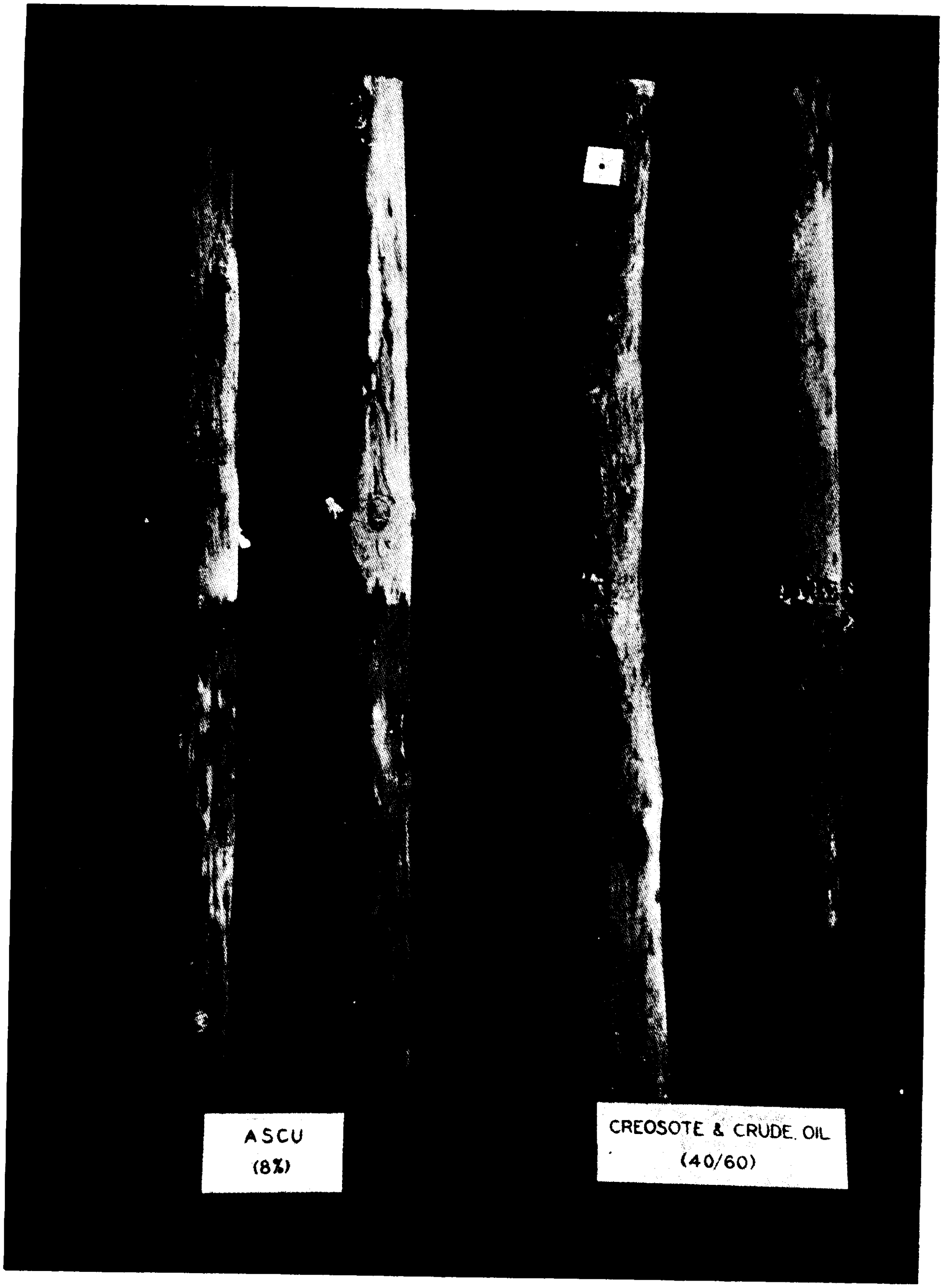
If therefore a brush treatment is to be given, let it be done as well as possible. In the first place the wood surface should be as dry as possible, and at least two coats should be given, the second one after the first has dried. The preservative should be flooded over the wood, rather than merely painted on it. Every crack or joint in the wood should be thoroughly filled with the preservative since any untreated wood surface is a vulnerable spot for the ready access of fungi or white-ants. Creosote and similar preservatives should always be used hot.

It has already been mentioned that to be effective for any length of time a brush treatment must be repeated periodically. No surface treatment with any preservative will remain effective in an exposed position for long, and brush treatments are really of very little use under such conditions. In interior and protected positions they are of

greater value, and provided the preservative coating remains intact, especially on the cross or end sections, it will act as a protective and prophylactic film over the untreated wood underneath.

The importance of starting with clean healthy wood is, however, not always fully understood, and in order to draw attention to this point, the photograph on the opposite page has been reproduced to illustrate the futility of using a brush treatment on wood in which fungus has already gained access. The four billets shown in the photograph are representative of 40 similar billets—20 of chir pine and 20 of sal—which were given two brush-coats of (*a*) hot creosote (20) and (*b*) Ascu (20) in July 1937, at the Forest Research Institute at Dehra Dun.

The photograph was taken about two months later, the billets having been inserted to half their length in the ground during the intervening period. It will be seen that two surface coats of neither creosote nor Ascu had any effect in preventing fungal fruiting bodies appearing on the surface of the wood. It is evident that the fungus in question was present in the wood before the brush treatments were given. The *mycelia* inside the wood were unaffected by the preservatives on the surface, and the fungus developed in the interior of the wood and eventually thrust out its fruiting bodies through the surface coating of preservative without suffering any ill effects therefrom. Practically every billet of the whole 40 showed fruiting bodies on the surface within about two months of the time of treatment. The fungus in question is probably *Schizophyllum commune,* a very common wood-destroying fungus in Dehra Dun which develops with great rapidity during the rains. The experiment is very instructive as showing the absolute futility of brush treatments on wood already infected with fungus. Numerous other failures with brush treatments are on record at the Forest Research Institute. A typical example is that of a floor of chir pine recently installed in the gymnasium of one of the numerous academic institutions in Dehra Dun. The specification was that the wood was to be brush-coated with a certain preservative. Such a specification, even if properly carried out, would have been of very limited value for the floor in question, and brush treatments generally should never be used for floors. The contractor, in order to comply with the specification, gave the surface of the floor a good-looking coat of the preservative, but omitted to be nearly so



Brush treatments with wood preservatives.

liberal on the under surface and the end sections, and made matters worse by sawing, planing, and fitting the floor boards and supporting joists after giving the superficial treatment. The result was of course that there were numerous places where the treated surface had been sawed, chiselled, or planed off, with the inevitable result that white-ants very soon found the vulnerable spots and were making a hearty meal of the floor when the damage was discovered a few months later. They had carefully avoided the treated surfaces, but had found no difficulty in discovering several places on the wood surface where the preservative had been removed during the fitting of the floor. Such a procedure was of course worse than useless, and any treated surface broken by subsequent planing or chiselling should have been given a fresh coating of preservative. The danger of leaving even a small spot untreated has more than once been amply demonstrated. White-ants and fungi have an uncanny way of finding such weak spots, and once found, a surface brush treatment loses completely any value which it may previously have possessed.

In conclusion, I would again emphasize the fact that a brush treatment with preservative is at best a not very effective type of treatment, and one which should never be employed for outdoor work or on timber to be used in exposed positions. For interior and sheltered work it has a certain protective value provided the treatment is carried out efficiently and every care is taken to see that no portion of the wood surface is left without a protective coating.

NOTE BY C. F. C. BEESON, I.F.S., FOREST ENTOMOLOGIST.

Surface brush treatment is also ineffective in preventing attack by powderpost beetles and pinhole borers, which bore in through the surface from outside. Experiments were conducted this year with (*a*) Ascu solution at a strength of 0.6 pounds in one gallon of water brushed on cold, and (*b*) the same followed by asphalt-crude oil suspension heated to about 50°C and applied after the preliminary Ascu coating had dried.

Poles of sal, semul and shisham were felled barked and treated in March in Dehra Dun division, U. P. Seven months later, in November, all the treated poles showed extensive damage by powderpost beetles and to a less extent by pinhole borers; in sal and shisham the boring was confined to the sapwood as is normal in these timbers; in semul the tunnels penetrated deeply into the heart.

Termites also damaged the wood entering through the butt ends or cracks or holes but not through the unbroken treated surface. Fungal fruiting bodies were abundant.

Poles of chir felled and barked in the winter fellings were similarly treated in April in the Chakrata division, U. P. By July several of the treated poles were attacked by pinhole borers; those remaining unattacked had dried out naturally to an extent sufficient to make them unsuitable for the development of borers.

FAREWELL FUNCTION HELD IN HONOUR OF MESSRS. CANNING AND MASON

A farewell function took place on October 8th, 1937, at the Hotel Metropole, Naini Tal, in honour of Mr. F. Canning, C.I.E., I.F.S., M.L.A., Chief Conservator of Forests, United Provinces, and Mr. L. Mason, B.A., C.I.E., O.B.E., M.C., I.F.S., Conservator of Forests, Eastern Circle, United Provinces.

Mr. S. B. Bhatia, Divisional Forest Officer, Pilibhit Forest Division, read out the following address to Mr. F. Canning, C.I.E., I.F.S., M.L.A.:

SIR,

We, the members of the United Provinces Forest Service, beg leave to address a few words of farewell to you on the occasion of your retirement after thirty-four years of distinguished service to the forests of the United Provinces.

You, sir, have been in charge of the Forest Department in these provinces from 1929 and during this period of eight years you have piloted the department through the storms and stresses of the past eight years, including the financial depression commencing in 1931, which seriously affected the forest revenues of these provinces. Under your sympathetic and efficient control, U.P. Forest Department has made steady and uninterrupted progress. Among the many successful achievements, whether inaugurated or continued, may be mentioned briefly the following main items:

The commercialisation of the rosin and bobbin companies at Clutterbuckganj which are now earning good profits from timber and other contracts, a substantial share of which is annually paid to

Government; the complete reorganisation of the silvicultural research; the change in the afforestation policy by encouraging landlords, by experimental demonstration and professional advice, to use their own resources in planting trees on barren lands, which in turn have led to a better appreciation of forestry work by the public, and to the betterment of their fuel and fodder supplies; the afforestation of the U. P. canal banks over some 15,000 acres, and the culture of fruit trees yielding increased receipts to the Irrigation Department of Rs. 34 lakhs in 1934 against Rs. 11 lakhs formerly; the communal management of forests in Kumaon, increased demands for less valuable timbers and soft woods for the match industry and for packing cases; the development of *taungya;* the steady output of sal sleepers in their struggle against steel sleepers increasingly used by certain railways and the preservation of wild life ensured by the United Provinces National Park Act of 1935, resulting in the constitution of the Hailey and the Nanda Devi National Parks which are entirely new features in the history of this department. The United Provinces Forest Department (Canning) Benevolent Fund inaugurated in 1932 will stand out as a memorial for all time to come of your burning desire to do good to those entrusted to your charge. In sports we have the commencement in 1930 of the Clerks' Tennis Tournament and the Forest Officers Tennis Club to your credit.

We can never forget the pains you have taken to ameliorate the condition of our service. It was in your regime that the number of posts open to the members of the Provincial Forest Service in the Indian Forest Service was raised from $12\frac{1}{2}$ per cent. to 25 per cent. and had it not been laid down by the Government of India that the promotions should be gradual most of us would have given you a farewell address in a different capacity. But times are hard and if with the best of wishes and all the support you have given us we have not been successful in achieving our object the fault lies with our own fate.

It has been both a pleasure and privilege to serve under you. There is no member of our service who is not deeply beholden to you for some kindness shown or some favour done. We owe you a deep debt of gratitude and we shall always gratefully cherish the memory of the peaceful and happy days we have passed in your regime.

It is with a heavy heart that we bid you and Mrs. Canning farewell. But in the midst of our grief it is a comfort to feel that you are leaving us in the care of one who has known us long and of whose sympathy and solicitude for our welfare we are fully assured.

That the Almighty may grant you, Mrs. Canning, and family good health and long life to enjoy your well earned rest is, sir, our fervent prayer.

Mr. F. Canning, who was profusely cheered when he stood up to reply to the address, thanked the hosts, some of whom had come up from distant parts of the province, and said that there had been great development and improvement in the status of the Provincial Forest Service and there were increased opportunities for advancements of the members. It was inevitable that the present Provincial Forest Service together with the present Imperial Forest Service with their present conditions of services must come to an end. But the new service by whatever name it is called will be quite distinct from the two services and until the new service attains the seniority and experience necessary to take over the administration of the forests a considerable time must elapse during which the honour and responsibility of the continuity of management must devolve on existing services. The success of the new reorganisation will very largely depend on the example set and the training given to the new recruits by the officers of the existing service. While therefore the anxiety in regard to the changed condition is natural there was no occasion to be downhearted.

There was a change in training and recruitment of the Imperial Forest Service from the Cooper's Hill of his time and of which he was one of the last officers in the service. This was thought at the time to be a great mistake, but it eventually proved advantageous to the department. He further hoped that recruitment and training to the new forest officers' service would be at Dehra Dun where all the Provincial Forest Service officers were trained and it would be initiated and maintained at the highest possible standard.

Finally he thanked them all for their help and co-operation in making the post of the Chief Conservator the finest in the department which gives the finest life in India.

Mr. S. B. Bhatia, Divisional Forest Officer, Pilibhit Forest Division, then read out the following address to Mr. L. Mason, B.A., C.I.E., O.B.E., M.C., I.F.S.:

Sir,

We have met here to-day to say good-bye not only to Mr. Canning but also to you, our popular and respected Conservator of Forests, in the Eastern Circle, U. P. After a very meritorious service in the war, which brought you the distinction of the Military Cross, in the Central Provinces, in the Andamans, and in other places, you were posted to the United Provinces in April 1934. During the brief period of three and a half years that this Forest Circle has had the good fortune to be under your charge, there has been all round progress, in spite of financial stringency.

Your open-mindedness, your unfailing courtesy, your masterly handling of situations, your great erudition and knowledge are some of the qualities that will always be remembered. God has endowed you with a nature which can never be ruffled, and to this you have combined an absorbing sense of duty and fairness. Yours has been a distinguished career: few people have had the honour of receiving so many titles. In fact you are so richly endowed with qualities that have raised you above your fellow men that one is inclined to accuse nature of so much partiality.

Sir, we are sorry to part, but we are happy that you are going to an elevated sphere to adorn the highest post in forestry. It is always a sad thing to say good-bye to the scene of one's activity, but in your case it is not really a farewell. You are not going into retirement, but, on the other hand, going to assume higher responsibilities on which the welfare of the whole of India depends. It will be now for you to lay down the future policy of, and create new traditions for, the department in the best interests of the country.

Forestry, sir, is a science still in its infancy. There are many intricate problems, which await solution, and a good many things which have yet to be explored. You have been a student of this science all through your life and have unabated passion for research. We are, therefore, confident that many of these knotty, intricate and difficult problems in research will be solved under the able guidance of your mature judgment and wide experience. In fact, your long and unrivalled experience in the practice of forestry, your quick grasp and

acute intellect, and your ripe scholarship and keen application will be invaluable to the State in the new office, which you are soon going to occupy. In brief, the country in general, and the Forest Department in particular, have great hopes from you.

Sir, it is generally said that destiny shapes our ends, rough hew them how we will, but we, on the other hand, hope with confidence that, while you will be bound to give your very best to the Government of India, you may still find time to devote yourself to secure for the Provincial Forest Services the interests of which you have so much at heart, the recognition of their claims, which they have been pressing for so long. We shall no doubt be poorer by losing you, but we rejoice in the feeling that your unrivalled talents will now be at the disposal of the country as a whole, and in a wider sphere you will be able to do greater service to India, and the interests of the Provincial Forest Services in India, which have suffered so long by default, will be safe in your keeping. That you may be long spared to discharge the high function to which you have been called and that God Almighty may grant you, Mrs. Mason and family long life, prosperity and happiness is our respectful wish and prayer.

Mr. Mason, in the course of his reply thanking the officers of the U. P. Forest Service for the generous spirit which had prompted them to present him with the farewell address, referred to the past three and a half years during which it had been his privilege to serve in the U. P. as amongst the happiest of his service due, he said, to the wholehearted co-operation all had extended to him.

He thanked them for the kind references to his new appointment. He appreciated greatly, he said, the honour of being the head of the finest forest service in the world, but he realised, too, the responsibilities attached to the post. He assured them that he would strive his utmost to uphold the high traditions set by his predecessors. He trusted that as many of them as possible would come and see him at Dehra Dun when visiting the Forest Research Institute where he assured them they would be most welcome at all times.

All forest officers in Naini Tal joined the party and a large number of officers came from all over the province. After cheers for the guests of the evening and the Conservators of Forests, the party came to a close.

REVIEWS

PROGRESS REPORT ON FOREST ADMINISTRATION IN THE JAMMU AND KASHMIR STATE FOR THE FASLI YEAR 1992-93 ENDING THE 30TH ASSUJ 1993 (15TH OCTOBER 1936).

Sir Peter Clutterbuck has again given us a most interesting account of the activities of the Kashmir Forest Department. The arrangement of the report makes it much more readable than those written on the stereotyped lines of British provinces and the well produced illustrations are a pleasure to look at. Provinces in India might well take this report as a model and endeavour to produce something less heavily stamped with the hall-mark of a Government blue book.

Although the Northern India timber market is said to have shown signs of improvement, it still has some way to go before it can be said to have recovered entirely from its period of depression. For this reason even the important forests are still being worked under a restricted yield, while distant areas are not worked at all. No one can doubt the wisdom of this policy, for Kashmir, with its enormous resources, is the one forest owner in Northern India who is able to produce any effect on the market. Even when prices are improving, the full yield cannot be released all at once, for the too hasty unloading of stocks on an unstable market might easily lead to another break.

Throughout the report there are indications of works, such as the construction of new roads having to be postponed for want of funds, but the financial results of the year's working give little cause for complaint. Receipts were maintained at just under Rs. 43 lakhs, the surplus of Rs. 30 lakhs being almost exactly 30 per cent of the gross revenue. A very satisfactory result and one which brings home the important part that the Kashmir forests play in the economic welfare of the country. As usual minor forest products contributed largely to the revenue, *kuth* alone producing nearly Rs. 5 lakhs, and resin over a lakh, in spite of restricted demand and reduced prices.

Kashmir has always prided itself on the high standard it has maintained in its working plans and it is satisfactory to notice that

adverse conditions have not been allowed to hinder this side of the department's work. As the report observes, the position continues to be eminently satisfactory; the heavy programme for the revision of the important deodar plans has been successfully carried out and although only two plans were sanctioned during the year, no less than twelve were in various stages of completion.

Under silviculture, the Chief Conservator has again to report the unsatisfactory progress of natural regeneration in many of the P.B.I.s that have been felled over, and for this reason, in the plans under revision, areas containing an abundance of advance growth with scattered overwood are being allotted to the Regeneration Block, and will be worked in the next few years. To make up for the deficiency of natural regeneration, artificial operations on a large scale have been resorted to, and no less than 725 maunds of seed were collected and sown and 842,000 seedlings were transplanted. As the Chief Conservator remarks, if this rate of progress is maintained it will not be long before the P. B. I. areas, worked during the last ten years, or so, are fully regenerated, so that by the time that the areas that have been allotted for working under the revised plans have been gone over, the earlier P.B.I.s should be ready for secondary and final fellings.

Reference is made to the difficulty that is experienced in getting rid of trees under 18″ diameter, which are marked in thinnings, and of "unfit" trees, which the lessees refuse to take over, and the opinion is expressed that it is better and safer to leave crops unthinned rather than to thin them and leave a mass of inflammable material on the ground, an opinion which not everyone will agree with, for, on the other hand, it may be argued that it is useless to spend a lot of money on growing even-aged young crops if their subsequent tending is to be neglected.

The report contains an interesting chapter on the Game Preservation Branch, which showed much higher profit without any curtailment of expenditure. What must have been almost the record trout, one of 13 lb. 6 oz., was taken from the middle Bringi, and the long list of really big fish show that fishermen received first class value for the Rs. 19,000 that were paid by them for trout licences.

H. L. W.

THE FAUNA OF BRITISH INDIA, MOTHS, VOL. V, SPHINGIDAE

By T. R. D. Bell and F. B. Scott.

(537 *pp.*, 15 *plates*, 1 *map*.)

The authors have an intimate knowledge of the biology of the hawk moths and for this reason have produced an unusually interesting book: they have not treated the species concerned solely as "museum pieces," dead moths mounted on pins, but have studied their early stages and biology in considerable detail. A feature of the book is the description of larvæ and pupæ; beautiful coloured figures of many of them, usually the work of one or other of the authors, are provided. The description of early stages is just as essential for systematic (and economic) purposes as is that of the adult.

The authors acknowledge full use of Rothschild and Jordan's classic "Revision" of the family in which both internal and external structures were minutely examined as opposed to the previous vague and unscientific method of describing only the more easily seen structures and the often variable colouration.

Keys to larvæ and pupæ are given under their sub-families and these, with the full descriptions and accurate figures, should be sufficient for the identification of a species. The authors have not studied larval chaetotaxy, on which the classification of lepidopterous larvæ is primarily based and it is possibly for this reason that they have been unable to make larval keys to the sub-families. It is to be hoped that representative larval specimens have been preserved for future study from this point of view.

In an appendix are given an interesting ecological account of hawk-moths in the Kanara District and lists of food-plants.

There is very little to criticize in this fine book, but the student should treat with caution the interpretation of some of the parts of the larval head (p. 6 *et seq.*) ; for example the labrum is here called the ligula although the latter is correctly stated in the glossary to be a labial part.

J. C. M. G.

EXTRACTS

PREVENTING FLOODS

The important rôle which the botanist could play, in co-operation with the engineer, in averting such disasters—conveniently dismissed as "acts of God"—as the recent floods in the Ohio and Mississippi valleys was strikingly emphasised by Professor E. J. Salisbury, F.R.S. of London University, in his presidential address to the botany section.

These disastrous floods, he said, together with the equally tragic droughts responsible for the American "Dust Bowl," were, like our own droughts and floods, "in no small degree capable of regulation by the proper utilisation of plant cover."

It was now probably recognised by many that those extremes of water supply were in large measure the outcome of lack of vision in respect to the proper integration, both spatial and temporal, of our exploitation of the soil surface. To-day we found that it was the engineer who had to be called in to mitigate results rather than the biologist to remedy the cause.

That was partly because the engineer's remedies, although extremely costly, were usually more immediate in their results and certainly more spectacular, but largely, he thought, because botanical knowledge on the applied side was inadequately organised to fulfil the important rôle it could and should play in co-operation with the engineer, for the communal well-being.

THE BETTER WAY

Afforestation of the catchment area of the Thames and other rivers would, in the long run, be perhaps far more effective and less costly as a guarantee against future floods or droughts than grand scale engineering works.

If they were to avoid floods and droughts, they must preserve rural England for practical as well as æsthetic reasons.

Another matter to which he would like to refer in that connection was, said Professor Salisbury, the much discussed question of the preservation of natural areas. The public generally needed guidance on those matters, which the student of plant life should furnish. Owing to the widespread ignorance of biological knowledge, the dynamic character of vegetation was by no means widely realised. There were, indeed, many educated people to-day who thought that to preserve an area all one needed to do was to leave it alone.

Professor Salisbury said that a sympathetic understanding of botanical thought and progress was essential to a community which was to deal adequately with such national problems as agricultural policy, land utilisation, afforestation, drainage, and water supply, the preservation of rural areas or the provision of national parks. —*Scotsman.*

THE EFFECT OF ASHES FROM FOREST FIRES UPON GERMINATION AND THE EARLY DEVELOPMENT OF PLANTS

By L. Fabricius

Forstwissenschaftliches Centralblatt 73 (8): 269—276, 1929.

(*Translated from the German by A. H. Krappe, March* 1935.)

In northern Europe the burning of forests, *i.e.*, the burning of slash from fellings after the final cutting, is still widely used, whereas in Germany and Austria it occurs, as is well known, only in isolated cases, as a survival from former times in the alteration of forest and agriculture and in the system of field-crops and oak coppice. The purpose of the burning of the worthless slash is either its destruction because it is regarded as detrimental to reproduction or because it is

desired to prevent accidental forest fires, but more frequently it is for fertilization and other types of soil improvement for the benefit of the new stand.

In the northern countries this method is by no means regarded as obsolete, and it is not thought desirable to replace it by the Central European methods. On the contrary people are convinced of its usefulness, and for the last 15 years the reports dealing with it have been exercising an ever increasing influence upon the views of German foresters. Heikinheimo was the first to publish a thorough work on this method as practised in Finland (*Acta forestalia fennica* v. 4, 1915) (in German); then there appeared, in 1926, in Vol. 10 of the *Acta*, an essay entitled "Investigations into the influence of forest fires upon forest vegetation in northern Finland" (in German) by Viljo Kujala. Furthermore, the Swedish Professor Eneroth published his "Contributions to our knowledge of the effect of the burning of the felled area upon the soil," published in German in the Anniversary Volume (Skogshögskolans Festskrift) of the Swedish Forest Academy (1928), and just now Prof. Tkatschenko of Leningrad has published in this review, 1929, pp. 109 and 169, an article dealing with the burning of the slash.

Still older than the combination of ground fires and forestry is the destruction of the wood reserves by means of burning to obtain pastures.*

The effect of the burning of the plant matter upon the soil beneath consists of a number of partial effects. It is still impossible to exactly define all of these. Some are sufficiently certain as far as their nature is concerned but their consequences can only be guessed. Much will depend upon the intensity of the fire, that is upon the quantity of the combustible material. The burning of a humus cover some centimeters thick upon the soil and the destruction of seeds and animal pests in the soil which requires a good deal of heat.

* Tkatschenko (*op. cit.*, p. 113) pointed out that in the Vedas of the Hindus soil burning is referred to. According to authorities, passages of the Brahmanas, one of the two large parts of the older Vedic literature and the date of which is not later than 800 B. ., contain references to the custom of burning old grasslands and thickets to obtain regeneration or to improve the pasture. From all these passages, and especially from one of them, which says that the cattle like to remain among the herbs grown on a newly burned land, it seems to follow clearly that the soil-improving effect of burning, which is of course lost soon after the burning was clearly recognized. At all events, Vergil, as Tkatschenko points out, was familiar with this effect, and so were doubtless our Teutonic ancestors.

cannot be obtained from ordinary surface fires. Deeper layers are protected by the poor heat conductivity of the top layers, even in stands with a great deal of down wood.

The myriads of microbes are bound to die even before the burning of the slash, and one might be tempted to attribute the favourable effect of burning, and also the noticeable increase of plant growth after a clear-cutting, to the fact that after the death of these microbes the higher plants find a new source of nutrients. At all events, the heating leads to processes of a colloidal nature, combined with changes in the degree of acidity which are bound to have some effect upon the physical qualities of the soil.

Thus it is possible to distinguish two groups of the effects of burning upon the soil: later effects, *i.e.* fertilization, and immediate heating effects (although there is a relation between the two). Of these effects Eneroth, *op. cit.*, has found two, the change of the reaction figure (pH) and the content of adsorptively bound lime. It is clear that the effect upon plant growth begins quite early, namely at the time of germination, and that it differs with each individual species. From this point of view Heikinheimo, *op. cit.* has investigated the forest species.

To test the total effect of burning upon the development of the new stand, the Bavarian Institute for Silviculture and Forest Utilization has started experiments over large areas, which can show results only after a lapse of years. The preliminary question, the reaction of the different forest species in germination and the early plant development to the ash cover of the soil, was tested again by an experiment carried on indoors, and it led to results differing in a number of points from the results attained by Heikinheimo. This experiment was started two years ago in flower-pots so as to be able to continue it with the greatest care and with the elimination of all factors that are uncontrollable in the open country. To exclude still further all accidents, the experiment was conducted in two simultaneous sets, and the whole double experiment was performed twice in succession according to a procedure established by a preliminary experiment. The arrangement was as follows: Unglazed flower-pots, 15 cm. in height and in upper width were filled to a point 5 cm. below the top with fine, fresh quartz sand. On the first of three pots was put a 1 to 1.5 cm. layer, or about 175 cc. of mold from an old

spruce stump. A second pot was similarly filled with wood ashes, requiring about 140 cc. of ashes, and the third was entirely filled with quartz sand to the height indicated. In the second set, instead of sand strongly humus-like earth was used, because in the course of time the sand formed very tight layers.

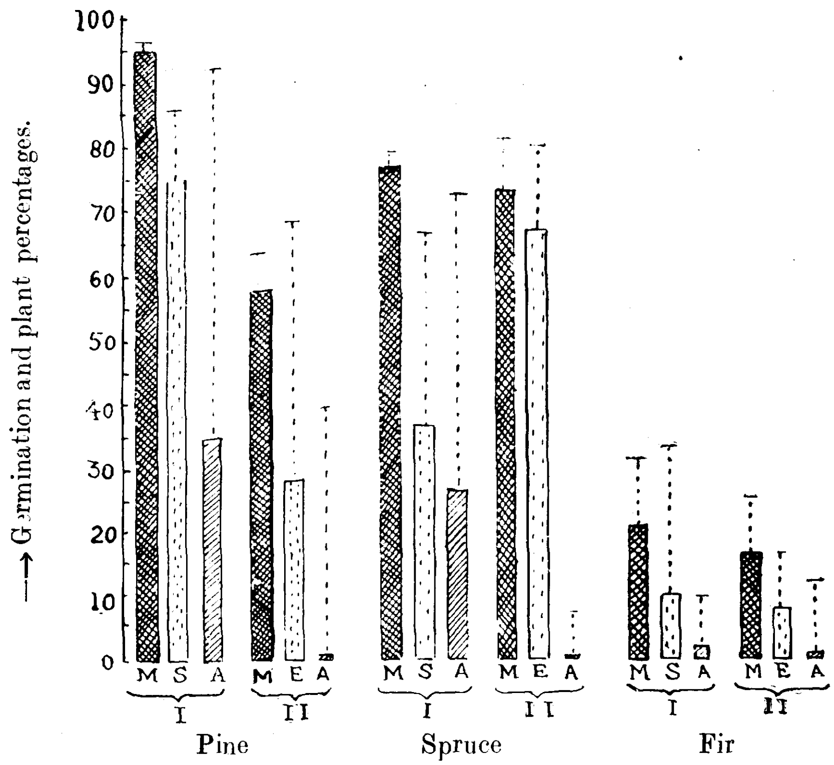
The ashes were made as nearly as possible like the ashes found in a burned middle-aged pine stand, and for this purpose "derbholz," faggot wood, needles, and bark from pine were mixed in approximately the natural proportion. A little moss and other soil plants and humus from a pine stand were added. The whole was burned completely on a heated iron plate, and the ashes thoroughly mixed. Also the quantity of ashes put in each pot was made approximately the same as the ashes obtained from the burning of a middle-age stand.

For each of the seed types to be tested six pots were used, so that each of the three modes of filling was represented twice. For the whole experiment there were 42 pots placed in a heated room near the window; these were watered by capillarity from the saucer and when this seemed insufficient, by sprinkling from above. As soon as the ashes were wet, they settled to a layer a few millimeters in thickness. The experimental species were spruce, fir, pine, black pine, larch, birch and beech. There were 100 conifer seeds, 40 beech seeds and 4 gr. of birch seed sown in each pot, and the pots were then protected with a glass cover.

The germination percentages and the condition of the plants were recorded, but only a brief summary of the results can be published. In the following section, I and II indicate the two sets of the experiment, from April 8th to May 31st, 1927; M means mold, S means sand, E means earth, A means ashes. The first experiment was terminated on May 25th, that is after 47 days, the second on August 5th, after 66 days. In the graphs, the number of plants that remained alive at the end of the experiment are given in the bars and on these bars the number of seedlings which died subsequently have been added by lines, so that the upper end of these lines represents the total number of the germinated seeds. In this the average is given, each time computed from the results of the two like pots (a and b); the results of the two like pots differed but little from each other. It is to be noted that each of these mean values has been

obtained on the basis of 200 seeds. In 200 cases, with the simple alternative of "germinated," "not germinated," or "living" and "dead," the probable error amounts at the most to 2.4 per cent. with a seed viability of 50 per cent.

M = Mold.
S = Sand.
A = Ashes.



The birch seed germinated so densely in 10 out of 12 pots that counting the seedlings was not possible without damaging the remaining seed. For this reason in the lower chart, only the number of the plants that remained alive have been given for I and II M and E, and only in II A the germination percentage was entered as a line, because it was not difficult to determine it in this case.

Since in the question of the success of the soil burning in forests, not the number but the quality of the plants is considered,

the seedlings were carefully weighed at the end of the experiments and the most favourable plant figure was always found in the mold. For purposes of a better comparison the plant figures of the other seed beds were given in percentages of the mold plants. The figures are given in the list.

From these graphs and figures together with the notes taken during the experiment we obtain the following facts for the different species.

I. Pine.

1. Very quick germination in A; all seeds capable of germinating do so, but there is a rapid dying off. The seedlings fall over, and in the ashes the radicles even lie on top of the ground. In the plants still standing the hypocotyl becomes brownish close to the soil surface and dries up. Very slow germination in S. In M very few die off; generally speaking, M is far superior to A as a plant soil and also considerably better than S. The surviving plants in A are, however, as healthy as those in S.

2. M and E are nearly equal at first. A lags far behind; although a moderate germination was possible in A, almost none of the seedlings were left. Here M is by far the best.

On a sand subsoil the development is better than on an earth subsoil. Ashes seriously interfere with the early development and are tolerated by a small number of plants only on a sand subsoil.

II. Spruce.

In contrast to the sand-loving pine, spruce developed better on E than on S; M was best even here. A was again very injurious, although the germination percentage on it, as compared with that on S, was not reduced any more than had been the case with pine. In II, germination failed almost completely in A. The surviving A plants in I, though only 30 per cent. of the plants in M, are at least as healthy as the latter.

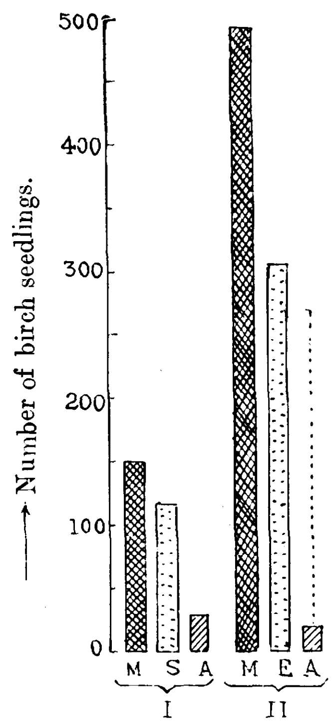
III. Fir.

Experiments I and II developed very much alike; in II nearly all figures are somewhat lower. M is in the long run doubtless the most favourable. Although in I S was superior during the first

three weeks, in II M was better from the beginning. A is very poor, germination lagging behind considerably and almost all the young plants after three weeks have fallen over and appear etiolated.

IV. Larch.

As with fir, there is agreement between I and II but II is throughout somewhat poorer. After two weeks the germination percentage in I was about the same in all six pots; in II it was somewhat higher on E, but in both experiments most plants remained healthy on M. S and E occupy middle ground; in A only a few remained alive in I or none in II, but these few are as good as the M plants.



Birch.

V. Black Pine.

From the beginning M had a good start in both experiments; at the end it had the most plants which, so far as quality is concerned, are not inferior to the A plants left in I. In II the ashes prevented all germination.

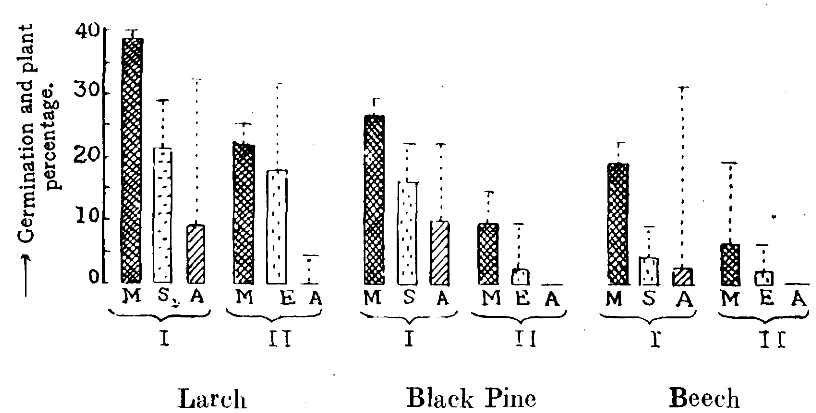
VI. Beech.

Each pot was planted with 40 seeds. It is surprising that A in I had the highest germination, namely 32, or 80 per cent. The fact that A completely prevented germination in II is in agreement with black pine. Larch, fir, and spurce also had small germination percentages in II A; only pine reached 40 per cent. Even in I the beech seedlings die off in A with but 2 exceptions. M again is far superior.

VII. Birch.

Here the seeds were not counted, but 4 g. of seed were carefully weighed for each pot. A had a detrimental influence in both pairs

of pots upon the seedlings. Two corresponding pots resulted in different germination figures, a fact which might be explained on the basis of the different degree of coverage and the fluctuation of the humidity. None the less in both experiments the order M, S (or E), A is perfectly clear. On sand, A almost completely prevented germination, on earth, about 50 per cent. of the germinating percentage of M germinated in ashes, thus M is again at the head of the list, but the seedlings in A almost completely died off. Experiment II, in contrast to almost all other seed species, gave much better results than experiment I (*cf.* also spruce).



RESULTS OF THE EXPERIMENT.

Of the seven species examined there is almost none that is in any way favoured by fresh ashes of the type resulting from a forest fire either in its germination or in the early plant development. On the contrary, the ashes are always quite harmful, generally reducing the germination figure.

Although the immediate heat effects of a forest fire upon the soil have not been tested by the experiment, it is improbable that they can eliminate the detrimental effect of the ashes and that there are species, the germination and early development of which may be supposed to be increased by forest burning.

Forest species.	Exp.	Germination bed.	No. of surviving plants.	No. of surviving plants in SEA in per cent of maximum (M).	Total weight of plants (g).	Weight of each plant (g).
Pine ..	I	Mold Sand Ashes	185 164 73	100 89 39	8·70 5·85 2·55	0·047 0·035 0·037
Pine ..	II	Mold Soil Ashes	116 58 1	100 50 ..	8·333 3·52 (0·002)	0·072 0·061 (0·002)
Spruce ..	I	Mold Sand Ashes	146 81 54	100 56 30	6·65 3·00 2·60	0·045 0·037 0·048
Spruce ..	II	Mold Soil Ashes	148 135 (1)	100 91 ..	10·61 9·10 (0·07)	0·072 0·068 (0·07)
Fir ..	I	Mold Sand Ashes	30 21 (3)	100 70 (3)	4·55 1·83 (0·20)	0·150 0·090 (0·070)
Fir ..	II	Mold Soil Ashes	33 16 (1)	100 49 ..	3·11 1·83 (0·10)	0·094 0·114 (0·10)
Larch ..	I	Mold Sand Ashes	77 41 19	100 53 25	2·00 0·80 0·50	0·026 0·020 0·027
Larch ..	II	Mold Soil Ashes	44 35 ..	100 80 ..	2·51 1·30 ..	0·057 0·037 ..
Black Pine ..	I	Mold Sand Ashes	49 32 19	100 66 39	5·50 3·50 2·10	0·112 0·109 0·115
Black Pine ..	II	Mold Soil Ashes	9 (2) ..	100	1·30 (0·20) ..	0·144 (0·10) ..
Beech ..	I	Mold Sand Ashes	19 4 (2)	100	13·70 2·60 (1·40)	0·720 0·650 (0·700)
Beech ..	II	Mold Soil Ashes	12 (3) ..	100	14·46 (3·16) ..	1·204 (1·05) ..
Birch ..	I	Mold Sand Ashes	150 115 26	100 77 17	.. .. ..	.. ..
Birch ..	II	Mold Soil Ashes	491 304 19	100 62 4	8·17 2·87 0·11	0·017 0·009 0·006

The proportion of viable seeds of a given species germinating and the number of seedlings surviving depends, to a great extent, upon the soil beneath the ashes. On sand the effect of the ashes is much less dangerous than on earth where very few of the seeds were left after 66 days. On sand the ashes never destroy all the seedlings. Those surviving after 47 days appear sound in the case of larch spruce, black pine and, to a lesser extent, common pine. They are, in fact, as good as the M plants, which points either to individual differences in the sensitivity of the plants to ashes or to a distinct limit of the injury caused by the salt concentration, a limit which is not reachd by unequal leaching in spots. Pine and spruce proved best fitted to reproduce on ground covered with fresh ashes; larch and black pine came next; birch failed almost completely. It is, therefore, no pioneer species on burned areas or at the most is so only when its winged seed is blown on such areas in large quantities.

If there is the necessary moisture, mold is most favourable for germination and the early development of all the forest species examined; it is better than sand and a soil rich in humus.

REDUCED PRICE OF "SILVICULTURE OF INDIAN TREES"

By R. S. Troup

There are a certain number of slightly damaged sets of "Silviculture of Indian Trees," by R. S. Troup, which will be sold at the *reduced* price of Rs. 20/- only to the forest officers and students of forest colleges and schools on the condition that not more than one set will be sold to each individual. Orders should be sent to the LIBRARIAN, Forest Research Institute, P. O. New Forest (Dehra Dun).

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for November, 1937:

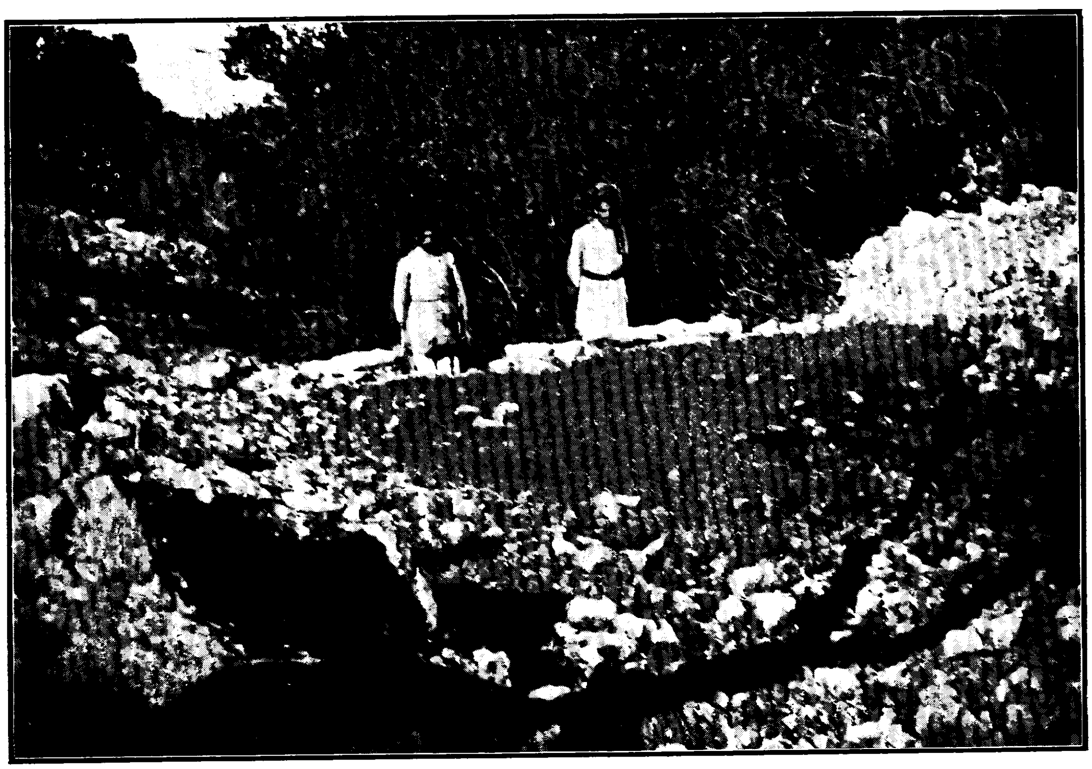
IMPORTS

ARTICLES	MONTH OF NOVEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
Siam ..	24	64	32	2,458	6,789	4,311
French Indo-China ..	..	498	159	..	46,400	18,486
Burma ..	..	..	13,954	..	..	18,59,613
Other countries ..	..	286	711	..	29,127	94,180
Total ..	**24**	848	**14,856**	2,458	82,316	**1,976,590**
Other than Teak—						
Softwoods ..	1,128	641	1,259	6,8694	35,158	87,345
Matchwoods ..	..	1,282	687	..	76,533	47,767
Unspecified (value) ..	..	..	..	1,57,794	18,377	3,00,739
Firewood ..	34	71	66	459	1,065	996
Sandalwood ..	17	41	..	6,997	11,344	..
Total value ..	..	..	..	2,33,944	1,42,477	4,36,847
Total value of Wood and Timber ..	..	..	..	2,36,402	2,24,793	24,13,437
Manufactures of Wood and Timber—						
Furniture and cabinet-ware ..		No data			No data	
Sleepers of Wood ..	..	..	180	..	..	13,557
Plywood ..	..	242	373	..	63,283	79,348
Other manufactures of Wood (value) ..	..	..	..	2,15,898	1,13,604	1,77,047
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,15,898	1,76,887	2,69,952
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	18,064	20,963	9,168	1,20,417	1,42,178	77,146

EXPORTS

ARTICLES	MONTH OF NOVEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	2,621	4,659	28	5,08,799	9,64,915	3,391
„ Germany ..	255	182	..	54,009	47,316	..
„ Iraq ..	35	49	10	7,934	12,204	3,583
„ Ceylon ..	199	220	..	35,112	39,026	..
„ Union of South Africa ..	225	353	..	37,663	68,269	..
„ Portuguese East Africa ..	183	288	..	31,228	49,214	..
„ United States of America ..	40	38	..	10,134	19,331	..
„ Other countries ..	442	351	54	89,335	72,842	16,784
Total ..	4,000	6,140	92	7,74,214	12,64,117	23,758
Teak keys (tons) ..	406	147	..	60,900	17,107	..
Hardwoods other than teak ..	96	92	..	13,542	8,934	..
Unspecified (value) ..	..	..	..	31,074	59,107	25,929
Firewood	..	..	..	..	..	..
Total value ..	..	..	..	1,05,516	85,148	25,929
Sandalwood—						
To United Kingdom ..	..	2	1	..	1,600	1,200
„ Japan ..	5	10	21	6,000	12,000	18,100
„ United States of America ..	101	50	51	1,00,810	60,000	50,000
„ Other countries ..	37	13	18	52,625	14,781	16,040
Total ..	143	75	91	1,59,435	88,381	85,340
Total value of Wood and Timber ..	..	..	..	10,39,165	14,37,646	1,35,027
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)..	..	..	..	9,035	18,350	19,932
Other Products of Wood and Timber ..	No data			No data		

A dry stone bund built in the Kalachitta Hills 1906—1908 which has remained intact because buttressed against solid rock at each flank. The accumulated silt carries a fair crop of wild oat grass.



Another example of an old bund built in limestone country in Kalachitta. It has remained intact for 30 years owing to its flanks being well supported by natural rock.

Photos : R. M. Gorrie.

INDIAN FORESTER

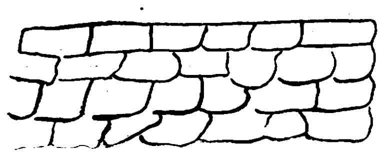
MARCH, 1938.

STONE BUNDS IN EROSION CONTROL

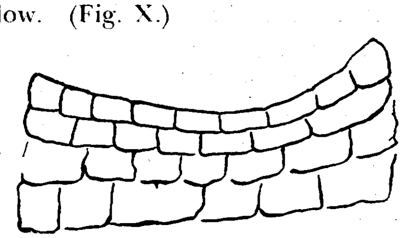
BY R. MACLAGAN GORRIE, D.Sc., I.F.S.

In the Punjab forest officers have been "erosion-conscious" for many years as is evidenced by the many reports which have been written in the eighteen-seventies and onwards. One also occasionally sees the remains of early attempts at erosion control engineering in different parts of the province. In the Pabbi many of the small stone bunds, built as long ago as 1880, can still be found more or less intact, and recently I came across some in the Choha block of the Kalachitta hills south of Campbellpur, which had been built in 1906-8.

A study of such old bunds gives us some valuable pointers. Most of those that have collapsed have been undermined by the water working round either flank and resuming its cutting action at one or other side. Those that have stood up best have been well buttressed on each flank against some solid object such as a large boulder or an underlying sill of rock, but such things are not always available. In their absence the best precaution against undermining is to have the sill hollowed to a concave curve, so that even with an appreciable flow of water, the main force of the torrent will be confined to the channel in which it is meant to flow. (Fig. X.)



Wrong Profile.



Correct Profile.

Fig. X.

The importance of this point in the construction was not appreciated by the early workers, with the result that a good deal of their labour has not stood the test of time. Examples illustrating success and failure are shown in Plates 11 and 12.

Another point of vital importance is the vertical spacing of bunds in a stream bed. Too few bunds are practically useless in preventing the further scouring out of a V-shaped torrent bed, because the stream regains impetus in the intervals and continues to cut down deeper. Bunds must be only so far apart that the top of each is practically on a level with the base of the one upstream from it. This ensures that each bund makes a flat terrace behind it, in which the water moves down without regaining much velocity. If this principle in laying out a torrent control project is ignored and the bunds are spaced much wider apart than this rule allows, it will inevitably prove a false economy, for the bed will be dug down deeper until eventually the bunds will be either undermined or side-tracked. An example of imminent undermining caused by this very reason is shown in Plate 12.

This question of spacing is so important that no project of bund-building should be taken up unless there is some reasonable prospect of being able to complete the whole of a given stream channel or at least the main section of its length where torrent action is evident. Isolated bunds put down here and there without forming part of a definitely planned and comprehensive project are just so much waste of money, unless they can be justified as a local trial of conditions and materials on a small scale and as a preliminary test leading to further work.

The close observance of this spacing rule will naturally make the treatment of steep nalas very expensive, because the steeper the gradient, the closer must be the bunds to each other. Stream gradients of anything up to a 1 in 8 fall lend themselves to this type of control and bunds can usually be built at a reasonable cost. Anything steeper than this entails a vast number of bunds, and it is suggested that, unless the torrent in question is of particularly vital importance, such as in the protection of important buildings or engineering projects, its flood control can be better handled by concentrating upon plant cover conservation in its catchment area. This, however, cannot be taken as an arbitrary rule and is put forward merely as a suggestion and in the hope that others who are gaining local knowledge of this type of work will be encouraged to give their experiences.

A bund which has collapsed owing to being unsupported at the flank. Man on left is standing in the new channel which the stream has cut out after being diverted out of its original path by the bund.

Another bund cut away on flank. Man on right is standing on compacted bed of accumulated silt caught by bund; man on left is on the new channel dug by the diverted stream which has undermined the end of the bund.

A 50-year old dry stone bund in the Public Reclamation Area which has stood up remarkably well to torrent action, but which is now being threatened by undercutting from downstream, the original mistake having been to place the bunds so far apart that torrent action has begun afresh on the intervening slope.

Photos: R. M. Gorrie.

PADAUK IN THE ANDAMANS

By B. S. Chengapa

Summary.—In this note the writer examines the behaviour of padauk in the plantations of the past and also its behaviour in the natural regeneration areas of the present.

In his interesting article "Regeneration of Padauk (*Pterocarpus dalbergioides*)—Artificial and Natural," published in the *Indian Forester* for July 1937, Mr. Subramanyam says that "the last word regarding the 'financial failure' or otherwise of pure artificial regeneration of padauk has not yet been said" and asks "whether it is not after all worth the trouble to go back to the plantation method of regenerating padauk or at least introduce some of the plantation technique into the 'pure' natural regeneration method."

Our past experience.—The South Andaman experience dates back to 1883. From this period up to 1921, 3,023 acres of plantations—1,657 pure padauk and the balance padauk mixed with teak or with *pyinma, koko* or white *chuglam* and other species—were raised at various costs. The early records show that these plantations held out hopes of great success. Referring to the early plantations, Chouldari and Dhani Khari, the Forest Annual Reports 1892-93 say: "These plantations have been most successful and there is scarcely a vacancy to be seen" and again (1896-97) referring to 1883 pure padauk: "A few of the trees are tall and well grown; the majority low and much branched.

"Most of the taller trees including the most promising have stumps of decayed branches protruding from the stem and threatening permanent injury to the bole.

"This is due to the shade of this species when planted pure being inadequate to induce a clean and healthy disarticulation of the lower branches, and appears to indicate that in future a judicious admixture of those species with which padauk is found naturally associated would be advisable." Mr. Bradley, then Chief Forest Officer, in his inspection note dated 13th July, 1922, on Sinkan plantations, says: "The *dhup* has still failed to appear but the padauk lines are flourishing excellently and have formed a dense thicket along the lines. The growth is healthy and the ground clean underneath as the padauk is so dense. As the padauk is 10

feet or so high there is no danger of its being suppressed, though it will be well to go along each side of the lines to cut any scrambling creepers." The subsequent records do not show any trace of complete neglect on the part of the management, nor is it likely that any management will go on, year after year, with about 100-200 acres of new plantations while neglecting the older ones. The presence of isolated padauk stumps in these plantations shows that the site is not an haphazard selection and the early records on Wimberleygunj plantations state that "The area was originally rich in padauk and a few old shells of padauk which were standing at the time of burning were burnt. A few small padauk were left in the lower portion of the area." Yet, of the 3,023 acres of plantations then raised, it is now found that only 1,582 acres—1,200 acres pure padauk—including what Mr. Martin, then Working Plan Officer, called "success with a stretch of imagination" are now considered worth tending. Indeed, Sir Alexander Rodger in his inspection note says: "In the Bomlungta valley there is a little teak and also about 1,000 acres of padauk plantations. Some small efforts have been made to keep these plantations clean but the greater part is overgrown with masses of softwoods." Mr. Foster, the present Chief Forest Officer, in his inspection note on Sinkan plantations observes: "The Extra Assistant Conservator of Forests showed me the most successful of these but I was most disappointed with the results; in fact it is impossible to appreciate that one is in a plantation as so many miscellaneous species have come in." In Wimberleygunj plantations the tale is not any different, the higher slopes have all reverted to useless jungle except for isolated padauk trees. What then is the cause for this failure?

One of the causes for past failures.—A great deal about the silvicultural requirements of padauk has lately been written and it is not proposed to go into those details now. However, it may be pointed out that the distribution of vegetation in the Andamans is purely edaphic and in nature it is not uncommon to see small patches of almost pure padauk though mostly it is found as isolated trees, some of them very far from each other. This is exactly what has happened in some of our plantations. Whatever other causes may have brought about this failure, it certainly appears likely that

the soil conditions are not uniformly suitable to padauk in any one block. It is also one of the elements of silviculture that any mistake in the choice of species in any locality will not be apparent until many years later, sometimes 20 or 30. Are we then justified in repeating the old mistakes? The North Andaman plantations are only eleven years old!

Is it then financially sound?—From the very outset padauk plantation was the rule and until 1926 the areas clear-felled for supply of fuel to the Settlement were taken for planting purposes. The cost of forming these plantations was therefore rarely more than Rs. 60 per acre. Cheap convict labour was also then available. The management, however, realised that even this figure was too high. Also, the world war brought many of the lesser known timber species on to the market. Various methods, therefore, both natural and artificial to raise these species and to reduce the cost of formation were tried and the question of natural regeneration engaged the earnest attention of the department since 1915. These attempts, however, failed and were abandoned and from 1926 plantations again became the order of the day. From this period, however, it became necessary to clear-fell high forests and to debit cost of felling to plantations. Sugarcane and maize were introduced as field crop to keep down weeds and to foster the healthy development of padauk seedlings. Padauk, *gurjan*, white *dhup* (*Canarium euphyllum*), *koko* (*Albizzia lebbek*), white *chuglam* (*Terminalia bialata*) and *lal bombway* (*Planchonia andamanica*) were planted. *Gurjan, dhup, koko* and *lal bombway* failed. Sugarcane and maize for want of purchasers were issued to elephants, but no corresponding decrease in their usual grain ration could be made. The cost of plantations for the first year's operation varied from Rs. 100 to Rs. 300 per acre. In 1931, Mr. Golding, then Chief Forest Officer, became alarmed at this enormous cost and ordered that every effort should be made to reduce the expenditure as far as possible.

Accordingly the problems of natural regeneration and also the question of reducing costs of plantations were again taken up.

As far as natural regeneration went it was soon found that by clearing all undergrowth and a skilful manipulation of the canopy we could "raise any species at will" including white *dhup, gurjan,*

koko and *lal bombway*, species that refused to respond to artificial methods, and Mr. Foster, in his inspection note of 4th September 1935, says: "All the regeneration areas were visited, that is Porlob, Kyitaung, Bajalungta, Guitar Islands. The results in all are amazingly good."

In plantations, the field crop was given up and the cost of formation was brought down to Rs. 80-15-0 in 1930 and Rs. 68 in 1931 and no further reduction could be made in the South Andamans.

In natural regeneration, the cost of formation in the beginning, as in most of the new undertakings, was high, though it was very much below the cost of plantations. It is interesting to note from the figures given below how steadily the cost was coming down:

1931	..	..	Rs. 48—1·0 per acre.
1932	..	..	„ 34—1·0 „
1933	..	..	„ 32—9·0 „
1934	..	..	„ 32—9·0 „

These figures include cost of operations for three successive years, *i.e.*, until the final fellings are completed when it may be said that natural regeneration levels up with the one year old plantation though this is an unfair comparison.

In the writer's article "Andaman Forests and Their Reproduction" in the *Indian Forester* for March 1934, it was mentioned that "no finality has been reached and nothing has been standardised" and also that "there is plenty of scope for improvement in the method and consequently for reduction in costs." Mr. Foster, in his inspection note dated the 4th September 1935, remarked that, "The more rigorously the canopy is removed the quicker the seedlings grow, but drastic opening causes increased weeding and hence expense. . . . There is very considerable scope for further experiment with a view to reducing costs. It might, for instance, be found in some localities that by rapid opening up the regeneration might get beyond reach of weeds in two years, and that the extra cost of weeding in the first year would be offset by avoiding weeding in the third year."

This suggestion was taken up immediately and in deciduous forests it is now found that initial fellings should be heavy and the final fellings should be completed within the second year. The

young crop then grows fast enough to be out of reach of weeds before the end of the second year.

As Mr. Foster says (inspection note dated 30th July 1937): "The ideas regarding the necessity of weeding in deciduous forests are crystallising out and we come to the following depending on the quality of the soil and consequent rate of growth of both weed and tree species."

1st year	..	2 or 3 weedings.
2nd ,,	..	1 ,, 2 ,,
3rd ,,	..	0 ,, 1 weeding.
4th ,,	..	No weeding.

This, of course, is going to make a very considerable difference in costs."

This has certainly made a big difference and the cost now varies from Rs. 20 to Rs. 23 per acre depending on the soil and includes all operations for two successive years including final felling. Further experiments are now in progress to complete final felling in the first year. This, if successful, will reduce the costs still further.

The lowest figure for plantations in the South Andaman varied from Rs. 60 to Rs. 80, and in the North Andaman Rs. 28 to Rs. 30. These are still higher than the figures for natural regeneration and represent costs of operation in the first year only. These figures naturally double themselves if these plantations fail as shown in the preceding paragraphs. Is it then financially sound?

Our experiments with natural regeneration have shown that regeneration immediately after extraction is nearly 40 to 50 per cent. cheaper. But unfortunately owing to the arrears of regeneration to be made good our P. B. I is in an area felled over 6 to 30 years ago and we are thus now paying for a recurring mistake of the past.

The object of management.—The object of management in the Andamans as pointed out in the editorial note published on page 449 of July number of 1937 is not padauk alone. It aims at padauk, *gurjan, papita* and *dhup* as the primary or controlled species and white *chuglam*, black *chuglam, pyinma*, etc., as subsidiary or uncontrolled species (to be felled only in the areas allotted for controlled species) and also as Sir Gerald Trevor, in his inspection note of February 1934 says: "any other species not at present in demand but possessing qualities which may make them valuable." One

such example is *Gyrocarpus americanus*, an excellent matchwood. In our attempts to raise *gurjan*, white *dhup*, *koko*, *lal bombway* and black *chuglam* artificially we were not successful. In natural regeneration, however, these species do not present any difficulty and indeed white *dhup* and *papita* are our spectacular species in some of our regeneration areas.

Is padauk the most valuable timber tree in the Andamans? Of the Andaman timber species, it is argued that "padauk is easily the most valuable timber tree." Mr. Mason (Forest Annual Administration Report, 1928-29) referring to white *dhup* and *papita* says: "The most remarkable feature of the year's working has been the continued and rapid development of the trade in softwoods as a result of the match industry in this country.

"Timbers which a few years back were unsaleable are now in such demand that sufficient supplies cannot be shipped to meet it. . . . Had this development occurred a few years earlier, it is probably safe to say that the erection of new mills with all the attendant cost and worries from the moment the log enters the mill to the time of the disposal of the output would not have been undertaken."

Apart from the initial expenditure on mills and "all the attendant cost and worries" our commercial accounts show a net profit per ton of logs as shown below:

	Rs.
Gurjan	1·36
Padauk	14·45
White *dhup*	5·04
Papita	7·51
White *chuglam*	9·87
Others	1·70

Padauk certainly commands the highest price, but talking with special reference to our new crop, it should not be forgotten that the rotation for padauk and *gurjan* is 150 years while that for *dhup* and *papita* is 80. Our profit therefore on *dhup* and *papita* at $3\frac{1}{2}$ per cent. compound interest accumulates to Rs. 56 and Rs. 85 respectively in 70 years, the difference in rotation before padauk can be put on the market. Is padauk then the most valuable timber tree in the Andamans?

Behaviour of padauk in a mixture.—Referring to the Inspector-General of Forests' inspection note of February 1934 which says that "to manage to get an average of 33 per cent. of padauk in the new crop arranged in groups and to leave the rest of the crop as a mixture of other species," Mr. Subramanyam says "experience has shown that under method 1 (natural regeneration) owing to the uneven germination of padauk, we are rather early if we do the cutting back during the first year, and if we do the cutting back in the second or third year the established plants have already suffered a set-back in growth. Methods 2 and 3 (plantations and natural *cum*-artificial) seem to be ideally suited for arranging this mixture with regard to padauk without any serious disadvantages." Let us examine the behaviour of this species in a mixture and see whether the natural regeneration method is really unsuited to it where it has to compete with other species.

In 1920 an area of six acres in Bomlungta was cleared of all vegetation, and early in the year teak seeds were dibbled. These failed to germinate. Padauk transplants were therefore planted as a stop-gap, and the area was kept weeded. A year later teak seeds germinated. As this was essentially an experiment to raise teak in alluvial soil, padauk seedlings were treated as weeds and were cut back until teak was well ahead. Teak grew fast and was promising. To-day it is a thriving padauk plantation with teak completely suppressed.

In Long Island, the 1930 and 1931 padauk plantations were abandoned in 1933 as the young crop was mercilessly browsed by deer and they soon became a sea of *Eupatorium odoratum,* making it impossible for even the deer to move about. To-day, these areas have become exceedingly interesting as all those stumps of padauk seedlings that had any life left in them have pushed their way through this impenetrable thicket. *Koko* also has behaved in a similar manner.

In Laltikri, 1931 area, the first successful natural regeneration experiment in the Andamans, early in the rains 6,000 to 12,000 seedlings per acre of all species came up. All visiting officers including the then Chief Forest Officer remarked that there is nothing but white *chulgam*. Nothing special was done to help padauk. A

Ranger was deputed in 1935 to make the first thinning with instructions to favour padauk as far as possible. To-day it is a pure padauk area with perhaps ten per cent. mixture of other species.

In Guitar Island, 1933 area, it was again thought that it was going to be cent. per cent. white *chuglam*. This was cleared and thinned personally by the writer in 1935, because of the rich soil, plants had grown very fast and early thinning was necessary. To-day it approaches the ideal set by the Inspector-General of Forests, *i.e.* mixture in groups, and Mr. Foster in his inspection note says: "When it was two years old, the Assistant Forest Officer carried out a thinning in the 1933 area. He reduced the crop to lines 8 feet apart so that the whole looked (and looks) like a plantation . . . the operation appears to have stimulated growth and the canopy is complete . . . seeing the crop now I am sure it is worth while if done by a gazetted officer; it will simplify all subsequent thinnings and in the second and third thinnings it should be possible to reduce the whole to automatic thinnings."

Padauk is undoubtedly the first to start germination mostly from seeds that have been lying dormant. Under adverse conditions it is also the first to disappear. Like all tropical species, it is a light demander and especially so in its seedling stage. Given suitable conditions it establishes itself within the first few months and once established it does not give up the struggle easily except when smothered by climbers. In fact even very old trees under most adverse conditions send up strong shoots.

It has been further observed in the past and is also the experience of the present that padauk seedlings grow very much healthier in a mixture of even erect weeds than when grown pure. It has also been found that constant and thorough weeding is injurious and very much retards their height growth. Indeed, as early as 1892-93, it was found desirable to have an admixture of other species to induce "a clean and healthy disarticulation of the lower branches."

In their struggle, however, padauk is left behind for the first three or four years. It is known to make a good mixture with *koko*, and, in our natural regeneration areas, it is not uncommon to see padauk on equal terms with white *chuglam*. After the fifth or sixth

year, with early weeding and clearing it outstrips many of its associates. Is there then any difficulty in raising padauk by natural regeneration method? Our regeneration areas so far thinned conclusively show that there is no such difficulty.

Poor results in Interview Island.—Referring to the Interview regeneration area, however, Mr. Foster says: "I was disappointed with padauk as there is not very much of it and it is a third of the other species . . . " and Mr. Subramanyam points out that "the area should have been a thriving padauk plantation if that intelligent attention which was necessary had been given to it from the beginning." Let us examine and see what led to this failure or to the poor quality of padauk in this area.

The Interview Island is an area where the American method of logging with a skidder was, for the first and also for the last time, tried in the Andamans. The skidder operation was abandoned in March and the area was taken up about the middle of October and the regeneration felling was actually completed in November or December when most of the padauk seedlings had disappeared. Can we then expect this to be a "thriving padauk plantation"? Timely work is a great factor in any of our silvicultural operations.

The technique for deciduous species now in practice is that all vegetation except that forming the topmost canopy is either felled or girdled and the refuse burnt. With the rains a large number of seedlings including a sufficient number of padauk appears on the area. All species with heavy seeds, *viz.*, white *dhup*, black *chuglam*, *badam* (*Terminalia procera*), *ywegi* (*Adenanthera pavomina*), etc., are usually confined to the vicinity of the mother trees. Species with winged seeds, *viz.*, white *chuglam*, padauk, *pyinma* and *papita* are found over the whole area although their main distribution is also near their mother trees. White *chuglam*, however, because of its heavy annual crop and the ease with which it germinates and flourishes, easily preponderates. But actually when spacing of the ultimate crop is concerned they are all well distributed.

Even from the first year it is never too early to group them in the course of first weeding supplementing natural regeneration of padauk if necessary with the transplants obtained from places of abundant germination. This necessity, however, rarely arises in practice.

In natural regeneration we are able to "raise any species at will" and its cost of formation is cheaper than that of the plantations. The results are "amazingly good." With little care and in course of time we can convert any deciduous area into reasonably pure padauk or any of its important associates. Our ideal, however, is each species in a group of its own, usually around the mother tree. Elsewhere, all species compete and nature ultimately makes its own choice. Failures therefore are highly improbable.

We have now reached the stage of first thinning and our line thinning shows that our subsequent thinnings may "become automatic." The important problem, therefore, of how to approach our future mixed crop for thinning and tending is near its solution.

In our experience of 54 years in plantation methods, we have been very unfortunate, our failure has been as high as 50 per cent. even excluding what is aptly termed "success with a stretch of imagination." The cost of formation is, therefore, doubled, making plantations financially thoroughly unsound The object of management is not pure padauk and in our attempt to raise some of our important species we have failed. Have we then pronounced "the last word regarding the financial failure or otherwise of pure artificial regeneration of padauk" too early?

FORESTS OF JANJIRA STATE

By L. P. Mascarenhas, Chief Forest Officer, Janjira State.

Janjira is also called Habsan. It lies between 17.59 and 18.32 north latitude and 72.57 and 73.21 east longitude. Janjira is the Marathi corruption of the Arabic Jazira—an island. The whole country is known by the name Janjira, though the name properly refers to the island fortress built at the mouth of the Rajpuri Gulf.

The area of the State is about 325 square miles.

Physiography.—Janjira is bounded on the north by the Kundalika river or the Roha creek; on the east by Roha, Mangaon and Māhad Taluqs of the Kolaba District; on the south by the Bankot creek and on the west by the Arabian Sea. About the middle of the coast line the great Rajpuri Gulf which for about fourteen miles runs south-east from the island of Janjira divides the State into two topographical divisions, *viz.*, the Northern and the Southern Habsan.

The country is very picturesque with a network of fairly wooded hills ranging from 100 to 1,300 feet high. The coast is generally green with ranges of wooded hills and near the mouths of creeks the shore is fringed by belts of palm groves from one to two miles broad. Inland, behind strips of salt swamps and mangrove bushes, lie the paddy flats, sometimes a mile or two broad and then rising to the lower slopes of the main ranges, in other places broken by cross-ridges that end at the waterside in tree-crested scarps. The creek banks and rising knolls are studded with hamlets of *Agris* who have at great labour converted the salt swamps into valuable rice fields; all over the hillsides are the huts of Katkaries and other hillmen.

The lower hillslopes are somewhat bare, except in the rains when patches of hill crops are seen.

The State is blessed with only one monsoon. The larger watercourses rise on the crests of high hills. Some of these are tapped for water supply to villages lower down, water being led by pipes under the gravitation system.

Climate.—The climate is of the usual monsoon type and comparatively temperate and healthy. The average rainfall is 110 inches and falls chiefly during the four months from June to September. The temperature varies from minimum 66 to maximum 99 degrees. The cold season is very short and mild. The humidity near the coast is high notably during the period of October to March.

Geology.—The whole Janjira State consists of hills composed of Deccan traps and some amount of alluvium near the sea coast. This geological formation, *viz.*, the Deccan Trap, is the same which covers the whole of the Bombay Presidency. The only useful products associated with these traps are those formed by the decomposition of the Deccan Trap and these are yellow ochre, red ochre and white clay.

All the hills of the Janjira State are made up of black basalt, which occurs up to a height of 500 to 600 feet, while above this height it is altered to laterite, a red porous stuff termed "Jamitra" in the State.

The basalt rock is of no great economic value but it provides good building and road material. Mixed with this laterite occurs bauxite which is an ore of aluminium and is of some value. It can be easily distinguished from the laterite as it is a greyish white colour and bears no forest growth.

Underground water resources.—As stated before, the whole country consists of basalt and laterite—generally laterite is found capping the hills over the basalt. A typical hill of Janjira State is composed of black basalt up to a level of 500 to 600 feet and over that laterite. Basalt is a very hard rock and non-porous; so all water which falls on it runs away through rivulets and streams to the sea and does not percolate below.

The best way to utilise the heavy rainfall is to construct dams across the valleys for the stoppage of water to be utilised for irrigation. Most of the wells get dry during summer and water scarcity is keenly felt.

Population.—According to the census of 1931 the population of the State is now 1,00,000, compared to 72,000 in 1872. The people are essentially agricultural and as such require pasturage for their cattle, timber and bamboos for agriculture, firewood and grass for thatching, thorns for hedges, and *tahal* lopping for ash-manure. In the more fertile low lands rice is grown, while the hilly and remote jungle tracts are used for raising dry crops by the wasteful and destructive process of *jhum* or shifting cultivation.

History.—Until 1860 the Janjira Chiefs took great care of their forests forbidding export and severely punishing timber thefts and injury to forests. Since then for nearly six decades all the unreserved forests were in process of wholesale destruction on account of uncontrolled *tahal* lopping, indiscriminate cutting of valuable trees for agricultural implements and collection of firewood faggots for supply to villages and important towns and lastly, and most important of all, the ruinous system of shifting cultivation. The marked effect of indiscriminate deforestation is that the rainfall instead of sinking slowly into the ground and running off gradually rushes down in destructive torrents which excavate for themselves deep ravines, carry down large quantities of debris and after covering large areas of the country with injurious material pass uselessly into the sea; the land which used to produce crops has been covered with sand, good soil has been carried away by the erosion of torrents and the level of water in wells has in places sunk to an alarming extent.

About the year 1925 the State authorities realised the importance of introducing regular management of both the reserved and unreserved forests and the need of a progressive but nevertheless con-

servative forest policy, and took the earliest opportunity of getting a regular working plan prepared for these forests. The prescriptions of the working plan were given effect to from 1926. The area of reserved forests is 41,930 acres, of protected forests 3,058 acres, of *khoti*-protected forests 6,315 acres, and of *kirdawa* forests 74,841 acres.

Legal position.—The State reserves prior to the survey settlement of 1890 were known as *Rakhsand* and were carefully conserved. At the time of the survey settlement they were surveyed and declared as reserved forests.

Apart from the reserved forests the State is partly the owner and partly the guardian and manager of all the tree growth existing elsewhere in the State and such areas are known as *Kirdawa* forests.

By the issue of the settlement circulars from 1890 to 1897, the State has reserved its rights not only to the trees mentioned below but also to the after-growth.

According to these circulars, rights over (1) the following trees, *viz., teak, shisham* (*Dalbergia latifolia*), *sandalwood, ain* (*Terminalia tomentosa*), *harda* (*Terminalia chebula*), and *mango* (*Mangifera indica*) belong exclusively to the State. The result has been that as the *Dharekaries* have no interest whatsoever in such trees, they do not hesitate to exterminate them whenever it suits their convenience. In order, therefore, to induce them to preserve these valuable trees and to encourage their growth, the following concessions were granted from the year 1934: (*a*) the State will charge as. 2 in the rupee towards management and supervision charges; (*b*) the *Dharekaries* will be entitled to as. 6 in the rupee in the revenue realised by the sale of *mango, ain* and teak, (*c*) regarding trees other than these "Royal" trees in *Kirdawa* forests the *Dharekaries* will be entitled to the full share of revenue realised at the annual auction sales of coupes laid out in their forests according to the prescription of the working plan, (2) all fruit trees; (3) trees giving shade to temples, mosques, *Ghotans,* State buildings, burial places and trees kept for public purposes, (4) all trees growing within 15 feet of road limits, (5) all trees near river streams, springs, tanks and wells.

The *Dharekaries* have practically very little control over the tree growth in *Kirdawa* forests, but they are permitted to lop for *tahal* under certain conditions with regard to the species and size of the trees to be lopped.

In the case of certain forests given as *inam*, the State has conferred all its rights including right to trees.

Composition and condition of the crops.—The composition of the forests is of a peculiar type, (1) Reserved forests containing (*a*) mixed teak forests, (*b*) pure *injaili* species, (2) *Kirdawa* forests containing mostly pure *injaili* species.

Amongst a very large number of species found growing, *kinjal* (*Terminalia paniculata*), *ain*, *harda* and *sawar* (*Bombax malabaricum*) predominate in the pure *injaili* forests. In the mixed teak forests, teak, *dhaman* (*Grewia tiliaefolia*), *ain* and *shiwan* (*Gmelina arobrea*) predominate. Almost all the hills are fairly well wooded but near Shriwardhan, Hareshawar and Murud they have been denuded of all tree growth.

The State has reserved certain areas as shikar reserves and these are more or less virgin forests. On some of the higher plateaus, groves of evergreen trees composed mainly of mango and *bherly* palm are found; the latter are tapped for toddy.

The natural regeneration of the principal species, such as *harda, ain, shisham, bibla* (*Pterocarpus marsupium*), *jambul* (*Eugenia jambolana*), *amba* (*Mangifera indica*), is satisfactory while that of teak is conspicuous by its absence.

The density of stock is fairly good; regeneration, excepting teak, plentiful and coppice is vigorous in reserve forests. In cultivated *Kirdawa* forests owing to early and indiscriminate lopping there is no proper supply of seed; hence regeneration is scanty.

The percentage of important species found on enumeration in sample plots is as follows:

	Mixed forests	*Injaili forests*
Teak	6.1	
Ain	3.5	2.4
Kinjal	..	68.4
Dhaman	2.8	
Dhawda	2.3	

Injuries.—The *Kirdawa* forests are subjected to the following kinds of injuries: (1) shifting cultivation of dry crops in which the whole area is tilled by rotation thereby destroying regeneration and

advance growth, (2) the demand for *tahal* is so heavy and continuous that there seems to be every danger of the tree growth on the *Kirdawas* being gradually exterminated. The country is completely without a "forest conscience" and a propaganda "save the trees and the trees will save the country" is being vigorously carried on since 1934.

Owing to the deplorable condition of these forests the State has promulgated certain rules from the year 1936 aiming at the general restocking of these denuded areas without affecting in the least the interest of the *Darekaries*. This is compulsory with those in possession of the *Kirdawas* of 15 acres in extent and more. They have to plant up two acres annually for every 15 acres with teak, *kinjal, ain, jambul, bibla* and *bhawa* (*Cassia fistula*). seedlings being supplied free by the Forest department and are entitled to a bonus of Rs. 8 per 1,000 plants found surviving at the end of two years.

The reserved forests are demarcated and the damage by fire and illicit removals is thus minimised.

System of management.—Before the introduction of a regular working plan, big blocks of reserved forests sometimes extending over 4,000 to 5,000 acres were sold to the highest bidder, the price per acre obtained being Rs. 20 and yield per acre 8 tons, on an average, as *kinjal* and *dawda* fetched a high price—as much as Rs. 25 to Rs. 30 per ton—in the Bombay market before the Great War. Karwar is now dumping in a lot of firewood and coal and electricity is largely used in Bombay, consequently the price of Janjira fuel has gone down and it is at present Rs. 14 to Rs. 18 per ton. The system adopted was simple coppice but all the inferior trees which yielded no firewood were left intact. Many of the trees were cut 2 to 3 feet high and the stumps of this height are seen everywhere in the forests with unhealthy and bushy shoots.

A working plan was drawn up in 1925 by the staff lent by the Bombay Forest department and since 1926 all the reserved and *Kirdawa* forests are being worked under sanctioned working plans, the method adopted being simple coppice, leaving *harda* and *amba* untouched.

Potentialities of the forests.—The Janjira forests are mainly firewood forests; the best *kinjal* and *dhawara* (*Anogeissus latifolia*) fuel cut in small size billets 2 to 3 feet in length and 15 to 24 inches

in girth fetched a comparatively high price—as much as Rs. 25 per ton two decades ago. The present selling price in Bombay varies from 12 to 15 rupees per ton as there is slump in the Bombay market. The next valuable produce is *harda* which is collected and exported to Bombay. This fetched a price of as. 12 per maund during the war, but now the price has come down to 6 to 7 annas. Then come teak poles which are available in small quantities and consumed locally. The items of minor forest produce are *sawar,* cotton, *shikekai* and *shembi* bark. Excepting a little local demand most of the fuel is exported to Bombay by sea. The maximum distance between a working area and the *bunder* is hardly six miles and road difficulties are considerably minimised. Material extracted from the steep hills is brought down to the coast on bullocks by *Charans* specially got from Ahmednagar or on carts along convenient tracts. All export stops in the rains. Coupes are sold annually to contractors in July each year; fellings and removal are arranged on daily wages or piecework.

The cost of felling, carting to *bunders,* transport to Bombay, including supervision charges come up to Rs. 12 a ton, while the selling rate varies from 12 to 14 rupees per ton. There is no lack of local labour which chiefly consists of *Marathas* and *Kunbies* who are industrious. They understand ordinary forest operations and carry them out satisfactorily.

Silviculture.—The reserves are divided into a fuel working circle with ten felling series and a teak pole working circle with two felling series. The *Kirdawas* form one fuel working circle divided into 9 felling series. Each felling series of *Kirdawa* forests is composed of a group of villages and the boundaries of the annual coupes have been so fixed as to facilitate the payment of the *Anewri* from the sale-proceeds later on.

Shikar reserves and *bherly* palm groves will remain untouched.

The rotation has been fixed as 20 years in the case of fuel felling series and 40 years in that of teak pole felling series.

About 2,400 acres of reserved forests and 4,600 acres of *Kirdawa* forests are exploited annually. The average yield of these areas is estimated at $3\frac{3}{4}$ tons and $1\frac{1}{4}$ tons per acre respectively.

The following table shows the estimated annual financial results:

1. Gross revenue from 2,400 acres of reserve forests at Rs. 15 per acre ... ... Rs. 36,000
2. Gross revenue from 4,600 acres of *Kirdawa* forests at Rs. 5 per acre ... ... Rs. 23,000
3. Revenue from minor forest products ... ... Rs. 20,000

The expenditure including charges under conservancy and works and that of the establishment comes to Rs. 23,000 per year.

Artificial regeneration.—The working plan prescribes under supplementary provisions that (*a*) *ain, kinjal, khair* (*Acacia catechu*), *dawara* (*Anogeissus latifolia*), and teak and *harda* seeds should be dibbled 10 feet apart and each dibbled bed should be surrounded by three or four flat stones; (*b*) in teak pole areas teak seeds should be dibbled in sufficient quantities on the burnt *rab;* (*c*) in the fuel areas *ain,* and *kinjal* seeds should be dibbled in suitable areas; (*d*) bamboos should be introduced wherever conditions appear suitable.

In lieu of the system prescribed in the working plan, the regeneration and cultural operations are being carried out in the annual coupes of the reserved forests; (*a*) the felled coupes are given over for *kumri* cultivation—areas containing well distributed coppice growth are excluded. The area should be cleared and burnt by the 30th of April without causing any damage to the coppice shoots growing on the area. It must be continuously cultivated for two years, first year with *nagli* and second year with *wari.*

Plants or seeds of teak, *harda, bibla, kinjal, bhawa, siris, sissoo, ain, khair* and *amba* should be introduced 6 feet apart by the stake system as soon as the crop is sown. The planting material will be given free by the department and the tenant is responsible to sow 350 plants per acre at the end of two years.

Where this is not possible the department itself takes up the restocking operations.

(*b*) In teak pole areas cleaning of coppice shoots is carried out departmentally in the year following as also cutting back of unhealthy and stunted seedlings.

In *Kirdawa* forests, as previously noted, the tree growth has been gradually destroyed and the soil has been eaten away by erosion; thus the steep hill-slopes are honey-combed with ravines which

have been cut by water action while the bare rocky cliffs tower upwards, and the work of destruction goes on apace. Each monsoon carries off its quota of silt and sand, some of it to the cultivators' fields below, some of it to silt up the river beds.

To control the sudden run-off and restore a vegetation cover trenches $48' \times 1\frac{1}{2}' \times 1\frac{1}{2}'$ are dug along the contours of steep slopes to catch and hold the water for the use of tree seedlings on the berm and check erosion. They actually serve as miniature dykes. The tree species that are tried include *Cassia florida, sissoo, siris, karanj, bhawa, cashew, moha* and *amba* mixed with *sandal* and *bogamedeloa*. During the last four years, 3,200 trenches have been dug all over the State. *Cassia* three years old is 16 feet, *sissoo* two years old is 13 feet and *sandal* three years old is 9 feet high.

Conclusion.—This brief account would be incomplete without a reference to the increasing personal interest which has been evinced by the Ruling Chief since 1934 in the management of his forest estate.

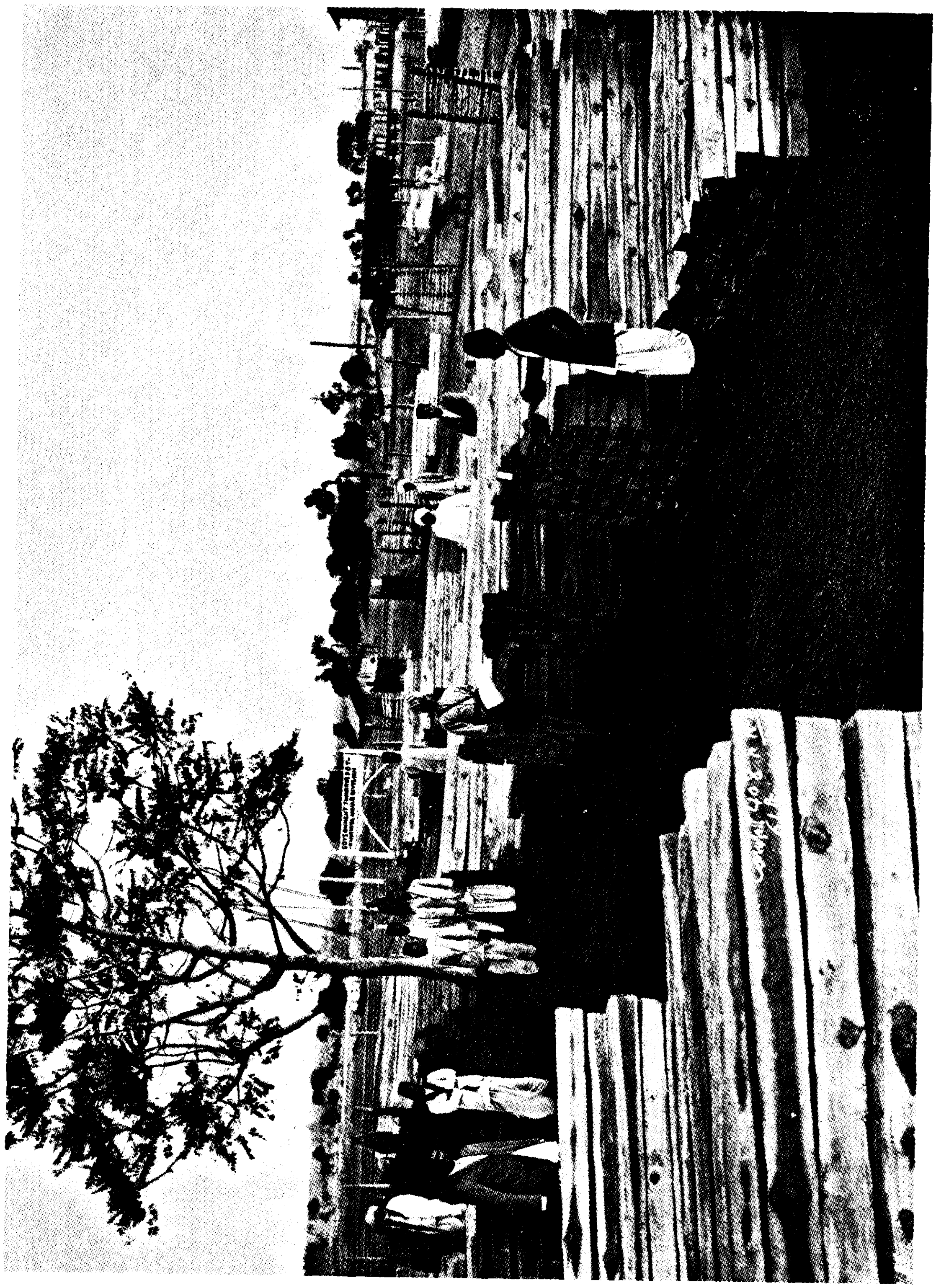
His Highness has a sincere love for forests as he is a keen sportsman. In these times of trade depression there is a general tendency to economise in all administrative charges, to restrict development, and above all to curtail establishment, but His Highness' policy is to go ahead.

DEPARTMENTAL EXPLOITATION OF FORESTS IN NIMAR DIVISION, C. P.

By S. A. Vahid, I.F.S.

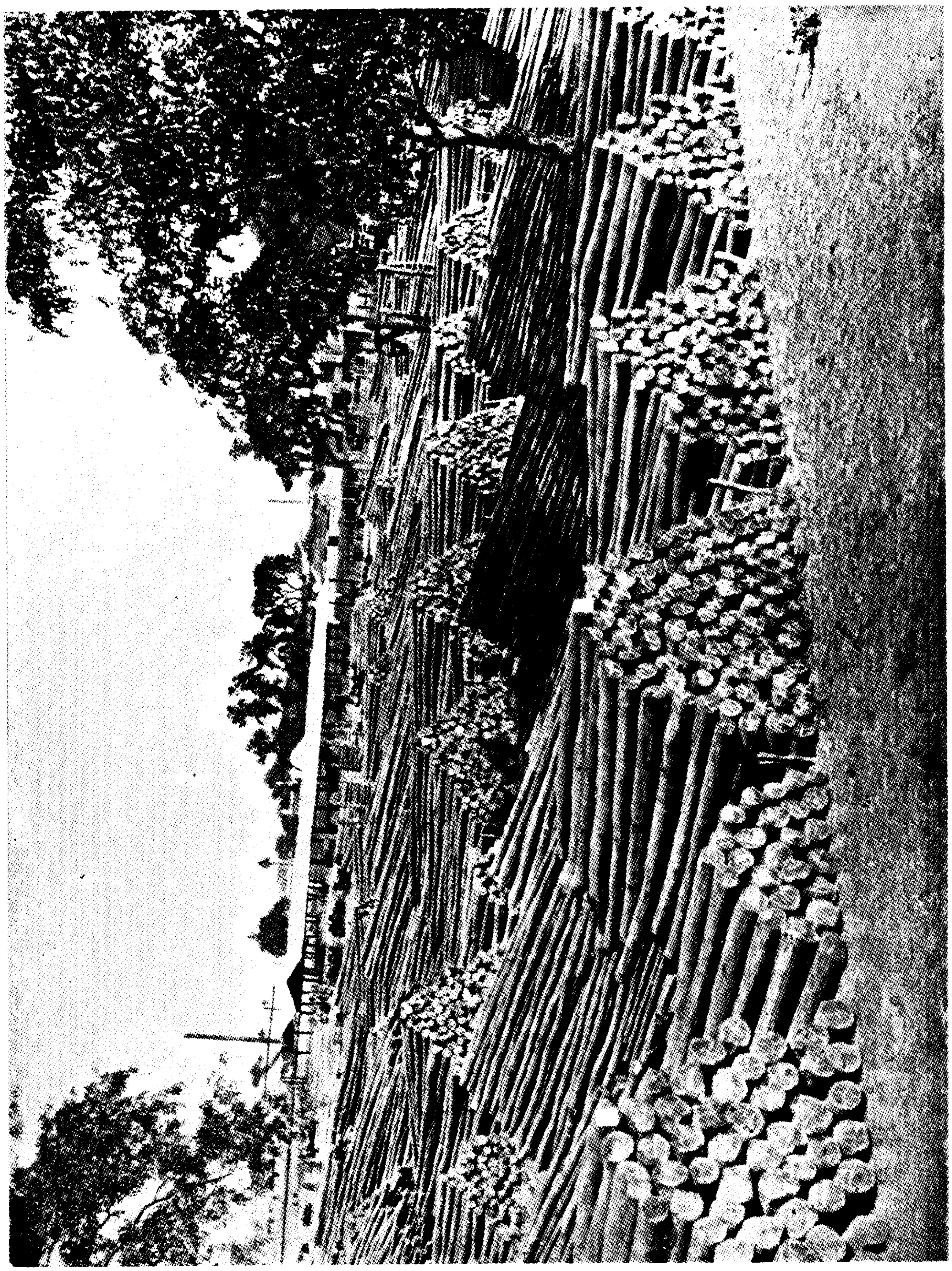
Summary.—As contractor's work in the forests of Nimar division, Central Provinces, was found to be unsatisfactory departmental exploitation of these forests was started in 1923. With experience improved methods were introduced and the results to-day are very satisfactory. Whereas sales at Khirkiya depot in 1926-27 amounted to Rs. 111 in 1936-37 these amounted to Rs. 1,15,912.

Most of the contractors working in this division have always been men of small capital and their working of the valuable forests particularly in the Kalibhit tract, which area comprises the most valuable forests of the division, was found to be very unsatisfactory, because they could neither invest sufficient capital nor organise labour on a sufficiently big scale to make the working of these forests



A corner of Khirkiya Depot.
(G. I. P. Rly.)

Photo Copyright:- S. A. Vahid, I. F. S.



Acorner of Khirkiya Depot,
Nimar Forest Division, C. P.

Photo Copyright:- S. A. Vahid, I. F. S.

practicable. There are numerous stories current about the large profits made by some contractors from illicit fellings in these forests, and while most of these stories are probably exaggerated they serve to show the difficulties of exercising efficient supervision over contractors' work in those days when there were no roads and no cars. As early as 1908, Mr. D. O. Witt, late Chief Conservator of Forests, C. P., had made the following remarks in the divisional Journal:

"Inspected extraction of timber from Coupe 11; Aonlia F. S. sold to contractor for Rs. 800. . . . Heavy extraction going on. Contractor has already sold Rs. 3,000 worth of timber. Coupes in this felling series should in future not be sold for less than Rs. 2,000. Better to work departmentally." To put an end to this unsatisfactory state of affairs it was decided in 1923 to start the departmental exploitation of the Kalibhit forests. A depot was opened in 1926 at Khirkiya on the G. I. P. Railway—about 60 miles from Khandwa. This place was considered to be the natural outlet for most of the Kalibhit timber. A road connecting Aonlia (the headquarters of East Kalibhit Range) with Khirkiya was constructed by the Public Works Department for the extraction of timber. This road is still unmetalled over a portion of its length, but attempts are being made to get this portion also metalled soon.

2. With experience it was found that departmental operations greatly facilitated works according to the working plan, considerably reduced the expenditure on subsequent cultural operations, and led to an appreciable increase in the net profit by cutting out middleman's profits, whilst indirectly they contributed in no small measure to the prosperity of the villagers by ensuring prompt payments at reasonable rates fixed by the Divisional Forest Officer. Hence the operations were extended to other ranges, with the result that the modest show at Khirkiya where sales of timber amounted to Rs. 111 in 1926-27 is now a flourishing depot and sales there in 1936-37 amounted to Rs. 1,15,912. Mainly due to the activities of the Forest department the small village of Khirkiya has grown into a flourishing centre of trade.

3. Ever since the inception of the departmental operations in this division attempts to organise works on better lines have been going on, and with experience improved methods of control have been adopted. It is hoped that the present method of working and

of keeping registers and records will be found interesting not only in other divisions of this Province, but also in other Provinces where the department may be experiencing similar troubles with contractors and may be wanting to introduce departmental working.

4. Although it was decided to start departmental working of the forests of this division as early as 1923 and the depot at Khirkiya was opened in 1926, it was the inspection of the depot by Mr. L. Mason, then Forest Utilisation Officer, Central Provinces, in 1931, that marked the turning point in the history of the departmental operations in this division. He made the following remarks in his inspection note: "The only reason that I can ascribe the failure to secure sales for the timber in the Government depot is that the local officials have not realised the need for making special efforts to attract buyers. One attempt to hold an auction has been made and that in May 1930, when the sales fell away in all districts on account of the passing of the Sarda Act. It is not sufficient to form a depot, to place timber in it and to put a notice board informing the public that the timber is for sale. There is no question that Khirkiya is an exceptionally well-situated centre for a timber depot and all that is needed to make it a success is a little enterprise on the part of the local staff and the placing of the sales organisation on a proper footing." As a result of his recommendations the operations were reorganised in 1931-32 and since that year gradual progress has been made in the organisation of sales, classification of timber, and recruitment of labour and carts. The following figures which represent the sales at Khirkiya depot during the last eleven years will give an idea of the progress made:

		Rs.	a.	p.			Rs.	a.	p.
1926-27	..	111	0	0	1932-33	..	71,481	3	6
1927-28	..	1,633	1	0	1933-34	..	97,697	1	3
1928-29	..	2,244	4	0	1934-35	..	1,02,177	3	0
1929-30	..	7,566	15	0	1935-36	..	1,13,958	3	6
1930-31	..	6,802	0	6	1936-37	..	1,15,912	0	0
1931-32	..	46,355	6	9					

5. In 1932-33 the new working plan came into force and according to its prescriptions greater quantities of timber were felled and marketed. But since 1932-33 we are actually felling less quantities of timber and the increases in sales as well as in net profit are solely due to better methods of organisation and control. The various

registers and forms maintained now show whether it would pay us to cart timber to Khirkiya depot or to sell it *in situ*. They also help us in keeping down the expenditure.

6. The present procedure is that the demarcation of the coupes to be worked during the next year is started about the middle of April, and marking is taken up soon after. A record of marking is kept in a register specially designed to meet our requirements in this division and numbered as Form No. 1. Marking itself is kept as simple as possible, and generally neither hammer marks nor numbers are put on the marked trees. The fellings are generally started about the middle of September and are recorded in the felling register which is numbered as Form No. 2. Fashioning of timber is not started till after the rains—sometime in October. During July carting rates from various coupes and compartments are fixed and submitted to the Conservator for approval. The basic principle in fixing the rates for carting is one pie per cubic foot per mile for *pucca* roads and $1\frac{1}{4}$ to $1\frac{1}{2}$ pies per cubic foot per mile for the *kacha* roads. At the same time rates for logging, dragging, and fashioning are also fixed and submitted to the Conservator for approval. These are fixed per cubic foot for *charpats* and per piece for other kinds of timber. It is necessary to mention here that for purposes of fixing rates as well as for sale the following classification of timber is adopted in this division:

Charpats—All rough squared logs are called *charpats*. Their volume is calculated by actual measurements.

			Length.	*Girth.*	*Form-factor for volume,* C.ft.
Goles,	No. 1	..	12′—15′	16″—18″	
,,	,, 2	..	16′—18′		
,,	,, 3	..	12′—15′	19″—21″	2·0
,,	,, 4	..	16′—18′		
,,	,, 5	..	12′—15′	22″—24″	
,,	,, 6	..	16′—18′		
Ballis,	,, 1	..	12′—15′	11″—15″	1·0
,,	,, 2	..	16′—18′		
Sagtis,	,, 1	..	12′—15′	8″—10″	·5
,,	,, 2	..	16′—18′		
Balanjas	..	..	7′—10′	6″—10″	·25
Jupias	..	..	7′—10′	11″—15″	·5
Karies,	,, 1	..	7′—10′	16″—18″	1·25
,,	,, 2	..	7′—10′	19″—21″	

7. The coupe *jamadar* keeps the account of all fashioning done in the coupe in divisional forms 3 and 4, form 3 being used for *charpats* and form 4 for the rafters. Account of sawing is maintained in form 5. An account of the receipt and issue of timber fashioned and sawn and paid for in any coupe or compartment is maintained in form 6. Balance is struck in this form daily and it can be seen by every inspecting officer as to what fashioned and sawn timber is available in the coupe on any day. For the checking of forms 3 to 6 frequent checks by the gazetted officers are necessary.

8. The carting of timber to the depot is generally started in October. All despatches are entered in divisional form No. 7. Each cartman carrying any timber is given a *challan* in form No. IX (*a*) F. E. 108. Instructions are that every forest officer and subordinate must check every cart he meets on the way taking timber to the depot. A party of cartmen is given two copies of forms from the coupe list or measurement book. This coupe list is maintained at the instance of the Accountant-General.

9. All timber received in the depot is entered in a register in divisional form No. 8. Another register in divisional form No. 9 gives an abstract of all timber received in the depot on any day, and the balance gives every inspecting officer an idea of the timber in stock. This balance can be readily checked and all inspecting officers are required to check it.

10. While the unit of receipt of timber in the depot is a cart covered by a *challan*, the unit of sale is a lot or stack arranged according to the quality and size of the timber. To help in conversion from one unit to another and to trace every piece received in a cart subsequently in the stack a lot register is prepared in divisional form No. 10. This register shows the pieces of timber in a lot or stack, and their origin. Subsequently at an auction sale the results of sales by lots are entered in a register in divisional form No. 13. Signatures of purchasers are obtained against the lots purchased by them. This avoids subsequent disputes.

11. As it very often happens that a particular purchaser buys more than one lot, and in all our subsequent dealings we have to reckon with the purchaser and not the lot, so now we register all our sales and the names of purchasers in form No. 14. This register shows at a glance the total timber purchased by any person and

details of payments made by him. A register of outstandings against purchasers is maintained in ledger form. This register helps us in taking timely action against persons who owe any sums to the department.

12. It was found with experience that while the registers maintained provided a good check of all timber in the forests as well as in the depot, there was no control over material in transit. Supposing 100 carts had left a coupe and only 50 were received in the depot that month it was not easy to trace the remaining 50 carts in subsequent months in the divisional office. In fact no check was possible until the close of the carting season. To provide this check a current account is maintained in divisional form No. 12 between the range officer and the depot officer, showing all timber received in the depot from the range. The balance between the timber received in any month at the depot and the timber despatched is checked with the first parts of the carting *challans*. If a cart despatched in any month is not received in the sale depot at Khirkiya even in the next month the Revenue Accountant brings the fact to the Divisional Forest Officer's notice and an inquiry is ordered.

13. Thus it will be seen that whereas forms Nos. 1 to 7 are devised to keep accounts of all timber felled and fashioned in the coupes and compartments, forms 8 to 15 are meant to keep control of timber in the depot. The maintenance of all these forms has been found to be perfectly simple and easy and with the help of these forms control of departmental operations at every stage is rendered surprisingly easy.

14. As remarked above carting of timber to the depot is generally started about October and carried on till the end of May. As soon as the best timber fit for Khirkiya depot has been carted from a coupe it is thrown open for the extraction of remnants on rated passes. Generally this is not done till carting to the depot is almost finished so that we may not lose the carts. All rates for the sale of remnants are sanctioned by the Conservator. The demand for fuel from most of the coupes worked departmentally is still poor, but it is developing as the demand for charcoal is increasing.

15. Generally one auction is held at Khirkiya every month beginning from December, and on an average about 40,000 cubic feet of

timber are carted to the depot every month. The farthest coupe from which timber is brought to the depot is 60 miles. With a little experience the staff soon learns what quality of timber should be sent from a particular coupe. While it may pay us to bring to the depot material of inferior quality from a coupe with a small lead, it will not pay us to bring material of the same quality from coupes with longer leads. The subordinates in charge of despatching timber are generally present at the auctions at the depot. These visits prove very instructive and give the subordinates an idea as to the fashioning and qualities most appreciated by the purchasers, and the condition of the market. Since the depression, prices fetched by our timber are poor. The average prices obtained are given below:—

		Rs.	a.	p.	
Sawn timber	..	1	0	0	per c. ft.
Charpats	..	0	13	6	,,
Goles	..	1	4	0	per piece.
Ballis	..	0	11	0	,, ,,
Saglis	..	0	4	0	,, ,,
Karis	..	0	9	0	,, ,,
Jupias	..	0	5	0	,, ,,
Balanjas	..	0	4	0	,, ,,

16. It may perhaps be urged that it is not necessary to maintain so many forms and registers, but as remarked above the maintenance of all these registers has been found to be very simple in actual practice. All these forms and registers enable the Divisional Forest Officer to keep a good control over the operations. Sitting in office he can say how much a rafter brought to the depot from a particular coupe should cost him, and if it actually fetches less than this or costs more he can immediately set things right. Owing to this strict control it was possible that out of total sales amounting to Rs. 1,15,000 in small lots each worth Rs. 15 or more during the six months, we did not lose over even a single lot. The procedure followed is still capable of improvement, but it is considered that it will be better to consolidate progress made so far, rather than intensify control at this stage. When it is remembered that all the new forms and registers were introduced only in 1933-34 it will be appreciated how quickly the staff has taken to them.

17. The one obvious defect in the whole system is that it is not possible at present to trace every piece of timber in the depot to the tree which yielded it. As most of the trees in this division are of small size it is at present felt that putting numbers on every tree will involve a disproportionate amount of labour. Then there is still scope for the extension of sawing operations and attempts are being made to teach sawing to the local *Korkus* as outsiders do not want to go to Kalibhit forests owing to their bad climate. Sawing in this division is confined to rejected pieces of timber not fit for carting to Khirkiya and any revenue from them represents money for nothing.

18. Before closing it will be interesting to mention that Mr. L. Mason again visited the depot in 1934 and made the following remarks:

"I inspected the depot after three years interval and it was unrecognisable from that I saw in 1930. Instead of a derelict plot of land with a few stacks of blackened coalescence representing the department's efforts to place their timber on the market, I find a well-ordered busy timber depot with some 20,000 cubic feet of well-dressed and attractive-looking squares, poles, etc. . . . . I examined the stacks which are being prepared for the next auction and while one can pick out a number of badly dressed squares and unsound ones which should in my opinion not have been passed for despatch to the sale depot, on the whole, the general standard both as regards quality and conversion is vastly improved on what was accepted in the earlier beginnings of these operations. The measurements were being taken of the timber received that afternoon and checked with those given on the carting *challans* . . . . While there has been a great improvement in the organisation of the yard and in the quality and dressing of the timber received, the greatest improvement perhaps has been in the check and control of the accounts."

19. During the last decade great progress has been made in forestry in India, and this progress has been made on different lines in different provinces. In the Central Provinces we have concentrated on the extension of the commercial activities of the department and the preparation of the working plans. The Forest Utilisation Officer has been able to create markets for timbers hitherto regarded as useless and to develop a demand for even well-known timber, *e.g.*,

sal scantlings, without which the future of sal would have been uncertain owing to the competition of steel sleepers, while the departmental working of the forests has by cutting out middlemen's profits enabled the department in these provinces to tide over the period of depression more successfully than in other provinces. The system of auctions by the Utilisation Officer has enabled the department to market large quantities of timber which the new working plans placed at its disposal without any difficulty. One can only hope that no passion for pinchbeck economies will be allowed to override important considerations of forest conservancy and departmental exploitation or to obscure the far-reaching importance of the latter to the welfare of the aborigines.

NOTES ON FORMS

Forms Nos. 1, 2 and 10 are not reproduced, form No. 1 is the working register and form No. 2 is the fellings register for recording fellings. Both these forms will depend upon the kind of working and the method of recording fellings. Form No. 10 contains rough notes on the composition of lots, and although an important record it is considered unnecessary to prescribe its form.

FORM NO. 3.

Register showing the account of fashioning of charpats in Coupe No.
Felling Series Range

Serial No.	Name and residence of fashioner.	Axe-fashioned *charpats*.		Amount.		Signature of payee.	Remarks.
		Serial No.	Cubical contents.	Rs.	a. p.		
1							
2							
3							

Form No. 4.

Register showing the account of fashioning of rafters in Coupe No.
Felling Series Range

Serial No.	Name and residence of fashioner.	*Goles.*	*Ballis.*	*Sakties.*	*Karis.*	*Jupias.*	*Balanjas.*	Amount of fashioning.			Signature of payee.	Remarks.
1												
2												
3												

Form No. 5.

Register showing the account of sawing in Coupe No.
Felling Series Range

Serial No.	Name and residence of sawyer	Serial number of sawn piece.	Superficial area.	Cubical contents.	Rate.	Amount. Rs.	a.	p.	Carting challan No. under which the sawn piece was sent to Depot.	Signature of payee.	Remarks.
1											
2											

Form No. 6.

Register showing the receipt and issue of timber fashioned, sawn and paid for in Coupe No. Felling Series Range

Date.	Particulars.	Axe-fashioned charpats.		Sawn material.		*Goles.*	*Ballis.*	*Sakties.*	*Karis.*	*Jupias.*	*Balanjas.*	Remarks.
		No.	C.ft.	No.	C.ft.							
15-4-1937 ..	Balance ..											
	Receipt ..											
	Total ..											
	Issue ..											
	Balance ..											
16-4-1937 ..	Receipt ..											

FORM NO. 7.

Register showing the account of timber despatched to Khirkiya Depot from Coupe No. Felling Series Range

Date.	Number of carting *challan.*	AXE-FASHIONED *charpats.*		SAWN MATERIAL.		*Goles.*	*Ballis.*	*Saktis.*	*Karis.*	*Jupias.*	*Balanjas.*	*Baglis.*	Remarks.
		No.	C.ft.	No.	C.ft.								
1-4-37 ..	125/1	1	8	3	12	2	..	..	..	..	..	..	..

FORM NO. 8.

Register of daily receipt of timber at Khirkiya Depot.

Number and date of carting *challan.*	Name and residence of cart man.	AXE-FASHIONED *charpats.*		SAWN MATERIAL.		*Goles.*	*Ballis.*	*Saktis.*	*Karis.*	*Jupias.*	*Balanjas.*	Total number of rafters.	Amount.			Remarks.
		No.	C.ft.	No.	C.ft.								Rs.	a.	p.	
125/1	..	1	8	3	12	2	..	..	..	..	..	2	12	0	0	

FORM NO. 9.

Register of daily abstract of timber received at Khirkiya Depot

Date.	Number of Coupe and felling series.	AXE-FASHIONED *charpats.*		SAWN MATERIAL		*Goles.*	*Ballis.*	*Saktis.*	*Karis.*	*Jupias.*	*Balanjas.*	Total number of rafters.	Total number of cart-loads received.	Remarks.
		No.	C.ft.	No.	C.ft.									
1-437 ..	Coupe IV, Ladwalia F. S. ..	12	60	20	100	50	20	10	..	..	..	..		

FORM No. 11.

Register showing the discrepancies as regards the number of pieces detected in Khirkiya Depot, Nimar Division

Date.	Number and date of carting *challan*.	Name of range and Coupe number and felling series.	Particulars of Timber despatched.		Particulars of Timber received.		Deficit or excess.		Signature of official receiving the timber with date.	Verification by Depot Officer.			Number and date of reference of action taken.	Result of inquiry if any and other remarks.
										Particulars of timber found in deficit or excess.		Signature of the verifying officer and date.		
			No.	C.ft.	No.	C.ft.	No.	C.ft.		No.	C.ft.			

FORM No. 12.

Account current with the Sale Depot Officer at Khirkiya of East and West Kalibhit Ranges, Nimar Forest Division.

Particulars.	Hewn Squares.		Sawn Timber.		Rafters.						Dhuras.			
	No.	C.ft.	No.	C.ft.	*Goles.*	*Ballis.*	*Saktis.*	*Karis.*	*Jupias.*	*Balanjas.*	*Tinsa.*	*Others.*	*Baglis.*	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Timber sent by Forest Depot Officer.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Timber received by Sale Depot Officer, Khirkiya.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Balance ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Discrepancy in measurements detected by Sale Depot Officer.	..	..	..	..	..	..	..	..	..	..	..	..	..	..

FORM No. 13.

Sale Register, Khirkiya Depot, Nimar Division.

Lot No.	Name of range.	Axe-fashioned *charpats*. No.	Axe-fashioned *charpats*. C.ft.	Sawn Timber. No.	Sawn Timber. C.ft.	*Goles.*	*Ballis.*	*Sagtis.*	*Karis.*	*Jupias.*	*Balanjas.*	Name of purchaser.	Sale amount by lot. Rs.	a.	p.	Sale amount paid by purchaser.	Signature of purchaser.	Remarks.
1	Chand garh.	20	150	..	..	..	..	..	..	..	..	Sant Singh	Rs. 200	0	0	Rs. 50		
2			..	..	..	..	..	..	..	..	..	..	..	..	..	..		
3																		

FORM No. 14.

Purchase Register, Khirkiya Depot, Nimar Forest Division.

Serial No.	Name of purchaser.	Residence.	Number of Coupe and felling series.	Lot No.	Kind of Timber. No.	Kind of Timber. C.ft.	Sale amount. Rs.	a. p.	Remarks.
1	Sant Singh	Poona.	Coupe IV Moctah	1	20	150	Rs. 200	a. p. 0 0	
2									
3									

FORM No. 15.

Register of Outstandings

Contractor __________ *of* __________ *in account with the Nimar Forest Division.*

Date.	Reference to Sale Register.	Sale price.	Date.	Amount paid.	Cash book Dr. item, number and date.	Balance of the amount outstanding.	Remarks.

THE FUTURE OF FORESTS

BROADCAST TALK BY E. A. GARLAND, I.F.S.

Summary.—This broadcast talk, given from Bombay (V.U.B.) on 26th September 1937, sketches in rough outline the part which forestry is capable of playing throughout the world in the development of the resources of the soil in the most economic manner. It admits the futility of any attempt to prophesy what may happen, politics all over the world being in their present uneasy state, but indicates some of the ways in which forests could, and should, contribute to man's well-being. Crops of trees and grasses are not only essential in some climatic and physiographic conditions, they are also capable of development, like any other agricultural crops, as the basis of raw materials for industries. To grow trees and establish their associated industries can also automatically involve the creation of living conditions for the workers which tally closely with the modern ideal. This transposes the old Latin tag "*rus in urbe*" into "*urbs in rure.*" Japan already practises what we preach.

Anyone who ventures, in these days, to prophesy what the future may hold must indeed be bold in his convictions, or even foolhardy. Yet to hope is man's prerogative and without faith in the future forestry becomes a farce. So I intend to-night to tell you something of the part which forestry is potentially capable of playing in that Brave New World of which we all sometimes dream. And I can assure you that it is no meagre part. I shall endeavour to do this as far as possible in general terms without boring you with technicalities.

Forestry has been described as being, in combination, an art, a science, and a business. There is a great deal of truth in that definition, which makes the business part of the proposition by no means simple to handle. A point which I want to emphasise here is that forestry is a form of agriculture and like all other forms of agriculture is, first and last, a business. This business is the conversion of the fertility of the soil into various crops and the disposal of these crops for cash, as raw materials for multifarious industries which vary from the manufacture of paper, or artificial silk stockings, to the building of ships. Some of the manufacturing processes are comparatively simple, such, for example, as the conversion of a tree into a log and of the log into beams, railway sleepers and planks. Others are far more complicated. In all cases, however, the raw material has to be produced as cheaply as possible and generally provides only a small margin of profit. There is also the difficulty that the crop, when reaped, consists mostly of bulky logs which are expensive to transport either direct to the markets or to centres at which they will be partially converted in the mills. Moreover

forestry involves an extra complication, which is far less applicable to other forms of agriculture, namely the time factor in production. With most other crops sowing, harvesting and marketing are possible within two years. Fluctuations in market demands and prices can therefore be forecast with considerable accuracy by a shrewd grower. With trees, on the other hand, 30 years is the least period which a crop will requre to reach maturity and for many species it may be extended to as much as 100 or even 150 years. This means that capital is locked up for a very long term and that large stocks have to be kept on hand in all stages of growth in order to maintain continuous supplies.

In the past therefore people have argued, and even to-day are sometimes heard to express the opinion, that forest crops are not worth growing and that the land occupied by them would be far better utilised under field crops with a quicker turnover, the cultivation of which also appears to give more employment for a greater number of people. Such arguments are not only fallacious in themselves, they are based upon ignorance of one of the most important and fundamental laws of Nature. Man has always been scandalously spendthrift with his resources and with nothing has he been more wantonly wasteful than with the fertility of the soil, upon which, in the ultimate analysis, his very existence depends. The world to-day is full of the most shocking examples of the terrible results of misuse of the soil through trying to force it to produce crops to which it was not properly adapted. These disasters are generally due to the fact that man has only quite recently begun to realise that there are two crops provided by Nature for the maintenance of fertility in the soil, for which under certain circumstances no substitutes are possible. These crops are grass and trees. Man's skill and ingenuity can develop them and improve them. But to attempt wholesale substitution of other apparently more profitable crops can only end in bankruptcy. The tragic floods in China and elsewhere, the ruinous duststorms in America and Canada, are due to neglect of this fundamental law of Nature. On steep mountain slopes where rivers have their sources and in areas with heavy rainfall a permanent cover for the soil is an absolute necessity to prevent floods and erosion of the valuable upper soil in which fertility is stored. The thicker this cover above the soil and

the deeper it penetrates into the earth with its roots the greater will be its efficiency for acting like a sponge and thus allowing the rain to percolate slowly to lower levels instead of running off the surface in torrential spates, causing increasing destruction and rushing rapidly to waste in the sea. To a lesser extent forests are also needed in districts of extensive plains for checking removal of the surface soil by wind. I will not enlarge upon these aspects of the necessity for forests which many experts have already dealt with far more ably than I can here. What I do wish to emphasise is that, while forests in some places are a necessity, a reasonable extension of them beyond the bare minimum of necessity for safety can change an otherwise unremunerative safeguard into a definite financial asset. Forest crops on steep mountain sides are usually of small commercial value and by themselves are generally uneconomic to work. Add to these more forest crops on better land at the foot of the hills and not only does the margin of safeguard thus provided increase very considerably but the two together then produce sufficient yield for the whole to be capable of economic working. There are various technical reasons for this which I will not enlarge upon now. But it is rather like, for example, keeping poultry. One old hen may lay an egg now and again but this will not pay for her feed. By contrast a properly organised poultry farm, which can guarantee a regular supply of eggs and chickens all the year round, will pay for itself and earn a profit into the bargain. In fact all soils and all localities are best suited to certain uses. Haphazard development in the past as the population has increased and spread has generally resulted in more or less extensive misapplication of land and consequent waste of natural resources. Only scientific examination and careful planning can rectify these errors.

This problem of the proper use of land is one the importance of which all civilised States are gradually beginning to realise. In agricultural countries—and incidentally all countries are really agricultural though they may sometimes obscure the fact—three phases in soil treatment can generally be recognised. In the first the original fertility is exploited by extensive or crude methods until the good initial yields begin to decline. In the second stage the good but depleted soil undergoes further croppings and poorer soils are brought under cultivation. These latter quickly succumb leaving

their occupants in a state of penury in which labour alone, however industrious, cannot achieve a real livelihood. In the third phase improvements are brought about by scientific treatment, the condition of the soil receives attention, its uses, after being carefully planned, are properly organised and crops respond by showing progressively increasing yields. Nor does the term "crops" mean only field crops such as rice, wheat and so forth. In a properly planned economic unit grass crops and tree crops are of just as great importance as field crops. Field crops use up the fertility of the soil. Grass and trees, especially the latter, build up fertility instead of dissipating it. In addition a village which contains woodlands has enormous advantages over one which has no forests, particularly if they are of sufficient extent to produce an annual yield sufficient to maintain a local industry. That perhaps may strike you as a propagandist statement coming, as it does, from a forest officer who may naturally be expected to believe that his geese are swans. I have no time now to develop this thesis fully. I can only state my reasons and leave out the arguments which justify them. First all agricultural activities are seasonal and all agricultural communities have busy seasons and slack seasons. Forestry lends itself admirably to being organised so as to provide occupation when other agricultural work is slack and when the villagers therefore have spare time on their hands and may be glad to earn extra wages. Secondly, for whatever purpose it may be required wood is a rather bulky and cumbersome raw material. In consequence much of the preliminary processing, if not the entire conversion to the finished article, is best done close to the site of production, that is to say the forest itself. Moreover since, as I have said before, trees take a long time to grow to marketable size—anything from 30 to 150 years according to species and requirements—the area of forest needed to keep even a small industry in continuous operation is necessarily large. Consequently the development of industries for which forests furnish the raw material can almost automatically involve the workers living in surroundings which combine just those compromises between rural and urban life which are nowadays increasingly regarded as approaching most closely to the ideal. Nor need it be thought that land devoted to forest crops is thereby necessarily entirely excluded from all other uses. Apart from its attractiveness to tourists and

Clear but unusual example of marked twisted fibre in blue pine.
Upper Siran, Hazara, N.W.F.P.

Photo : R. M. Gorrie.

holiday-makers on account of its coolth and beauty, apart also from its lure for the shikari and the naturalist, it can also, under proper management, provide shade and fodder for limited numbers of cattle and some temporary cultivation of field crops in conjunction with the planting of new tree crops. Lastly, wood as a crop or as raw material has special advantages in that practically nothing need be wasted and a forest can give employment of some sort to almost every type of person: the old woman who can gather sticks for firewood; the youth who can roughly trim fencing posts; the skilled craftsman who can produce the finest examples of turnery and carpentry. If one thinks for a moment of the innumerable things—some complicated, some simple—which are, or can be, made of wood, it will be obvious what scope exists for the development of small industries in those villages which are fortunate enough to have forests close to their doors. The usual idea is that in a country much of which is forest, the populace must necessarily be small, backward and impoverished. Facts quite contradict this belief. Japan is the third most densely populated country in the world with 358 persons to the square mile. Belgium has 702 and England 468, while the population of India is only 37 to the square mile. Yet, in a country so densely populated as Japan and which moreover can by no means be accused of neglecting to develop her industries, more than 67 per cent. of the total land area is under forest or afforestation. I consider that those figures give cause for thought. Good-night.

REVIEWS

ELEMENTS OF FORESTRY

BY FRANKLIN MOON AND NELSON COURTLANDT BROWN, 1937

(*John Wiley & Sons, New York; Chapman & Hall, London. Price 17s. 6d.*)

This is the third edition of this text-book on American forestry by Nelson Courtlandt Brown, Professor of Forest Utilisation in the New York State College of Forestry at Syracuse University and the

* Please also see the Editorial note about *Viscum articulatum* in this issue.

late Dean Franklin Moon. Like most American forest publications of this class, it is nicely bound and printed and copiously illustrated.

This publication is said to have served as a text-book in many American schools and colleges during the past 20 years, but it would be of very little use to the Indian forest student. It is a general text-book which in one volume of 397 pages attempts to cover practically the whole field of forestry. 90 pages alone are devoted to a discussion of the history, social economy and ownership of forests in the United States. Another 50 pages are devoted to the organisation of State and private services. These and allied subjects might well form a separate introductory volume to the study of forestry and, as we have pointed out before, there is scope for such an introductory publication dealing with the forests of India.

The remainder of the book deals with what may be referred to as the chief technical branches of the science of forestry, *viz.*, silviculture, management, utilisation, protection and forest policy. For India, it would be quite impossible to deal adequately with all these subjects in one volume even for the training of our forest ranger students. But it must be remembered, as the authors point out, that intensive forms of silviculture generally cannot yet be justified in the United States. Keeping this in mind, this general text-book on forestry is an excellent publication likely to meet the needs of the average American student.

W. T. H.

FOUNDATIONS OF SILVICULTURE UPON AN ECOLOGICAL BASIS

BY J. W. TOUMEY

SECOND EDITION. REVISED BY C. F. KORSTIAN, 1937

(John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 22s. 6d.)

It was the axiom of a well-known forest officer that to be a good forester a man must have his "forest sense" well developed. This is not entirely, as students sometimes seemed to think, something that a man must be born with, but a good "forest sense" implies a proper understanding of all the factors that combine to make and to influence the composition and development of a forest, an appreciation of their relative values and their interactions,

and the power to distinguish as far as possible cause and effect in the great variety of forest conditions; or, in other words, a thorough grounding in what has been called briefly "the foundations of silviculture." We are still a long way from perfection in interpreting cause and effect, but in comparatively recent years great strides have been made by the development of the science of ecology, which, basing itself on all other sciences, concerns itself with the relations of plants and animals to their environment.

"The Foundations of Silviculture upon an Ecological Basis," by J. W. Toumey, Professor of Silviculture at Yale University, published first in 1928, brought together the researches of the forester and the ecologist on all the factors affecting the forest. It was a good book, serving a very useful purpose, for not only did it give the student a scientific background for the development of his "forest sense," but in so far as it was a compilation of material from many sources, and had many references to the recent work of the time, it presented to foresters a clear account of the progress made in the foundations of their profession.

The second edition of this book, revised by C. F. Korstian, Professor of Silviculture, Duke University, has been brought out at the suggestion of Professor Toumey just prior to his death in 1932. It is justified by the recent advances in forestry, ecology and plant physiology. Many portions of the first edition are reproduced *verbatim*, in a conscious effort to retain as much of the original material as was compatible with recent advances, but a considerable amount of new material has been added, and there are frequent references to literature, bringing the book up to the beginning of 1937. Certain chapters have been rewritten, notably the one on soil (VI), which has been very much improved. The sections on soil profile, soil development and soil structure, and on mycorrhizæ are a few of the good points of this chapter. The opportunity has also been taken to rearrange many of the chapters: the book is now divided into three parts instead of the former two, namely, I—The Environment of the Forest (dealing with the various site factors), II—The Influence of the Forest on its Environment, and III—The Forest (working up logically from the tree to forest communities and succession).

It is specially mentioned in the preface to the second edition that no attempt has been made to cover all of the recent advances, but that material illustrative of particular principles has been selected. There are places, however, where one wishes more had been added. To mention two only, more could very well have been given on the factors that influence frost damage, and on the relation of the base exchange reaction of a soil to other factors and to the vegetation.

In places suitable reductions or omissions have been made, so that the book is only slightly longer than its predecessor. But there are instances where still further reductions could profitably have been made. For instance, in the earlier chapters it is assumed that the reader has a certain amount of forest and other scientific knowledge, and is acquainted with such things as stomata and palisade tissue, the symbol μ and the term hydrogen ion concentration, while there are frequent references to the crowns and roots of trees. The reader, having reached page 231, might therefore have been spared the solemn statement at the beginning of Part II that "The part of a tree above ground or the shoot system is composed of the shaft or bole and the crown. The part below ground is the root system."

These, however, are minor defects. The book as a whole is definitely good, and is a considerable improvement on the first edition. Being an American book, there are certain references to American conditions, such as the classification of United States' soils, the account of American animals under the biotic factors, and the classification of part of the American forest areas and cover types. But these only occupy a small portion of the book, and are in any case of interest, and in no way detract from the general value of the book, which deals with the subject as a whole on broader lines. It is a book that should be read by student and forester alike, and for those who wish to delve into any subject further, there is a very good bibliography of 32 pages at the end. The printing and binding are good, and although perhaps the price might have been somewhat less, it is not really unreasonable as modern scientific books go.

E. C. M.

EXTRACTS

TIMBER RESEARCH AND UTILISATION

The Timber Research and Utilisation Exhibition which opened at the Science Museum, South Kensington, on Thursday, is, in the words of the two men, who have collaborated in its arrangement, Mr. G. H. Donald, B.A. (For.), of the section of Timber Industries of the Forest Products Laboratory, Princes Risborough, and Mr. B. Alwyn Jay, M.A. (Cantab.), Assistant Technical Director of the Timber Development Association, the most comprehensive that has yet been organised in this country.

When a representative of the *Timber Trades Journal* attended a special preview on Wednesday afternoon, he found the officials engaged in putting the finishing touches to the Exhibition in readiness for the formal opening by Lord Kennet on Thursday. The exhibits are grouped in one large room at the Science Museum, Gallery 1, and each exhibit has been labelled with care and thoroughness, rendering a catalogue unnecessary. For the most part the exhibits are the property either of the Forest Products Research Laboratory or of the Timber Development Association, but a few come from outside sources.

A Wide Range

The subjects covered in the Exhibition are extremely wide, ranging from the geological side to the saw milling. A section which deserves to be mentioned first, not only for its interest, but for its primary position in the history of wood, is the geological section. This includes specimens of wood believed to go as far back as 350,000,000 years. A particularly striking example is a piece of Pliocene fossil oak, 25,000,000 years old, which still preserves detail and shape. In some cases woods of remote ages are placed side by side with their modern equivalents and a striking similarity can be found between them. The specimens in this section have been lent by the Geological Museum and the Natural History Museum.

Another interesting historical group is that of ancient woodworking tools, which has been lent by the Science Museum.

There are numerous sections devoted to the subject of timber-testing. This is actually, according to Mr. Donald, the first time

that the Forest Products Research Laboratory have shown the processes of timber-testing on any large scale. Most aspects of the work are shown. There is a half-sized model of a tumbling drum, which is used for testing the endurance of wooden containers. The drum, in the form of a wheel, makes one revolution in a minute, and the container, placed inside, is thrown about at all angles. A special arrangement induces a corner-drop—a primary test on containers.

Though limitation of space obviously preclude the exhibition of the full-size apparatus used in strength testing, the nature of the machines used is indicated by the photographs. The machine used to test the strength of clear timber is called the multiple lever universal motor-driven testing machine (of which a small model is shown), and in conjunction with this the various appliances are exhibited that are used to test timber for hardness, cleavage and shear parallel to the grain. A model of a compression cage used for tests on bobbin-shaped specimens is also included.

Different methods are used to test structural timbers. A particularly educative display comprises six joists, three of which have been accepted under the L. C. C. timber byelaws of 1937, and three of which have been rejected. Each was submitted to strength tests, and in the case of those rejected under the byelaws the reason for their rejection is demonstrated, and includes such things as deep seasoning checks, boxed heart and over-large knots. Another interesting exhibit in this section of the Exhibition is a part of the apparatus used to test joists. A joist has been placed in position, and letters painted on it indicate the points which are to be tested for strength.

A well-planned exhibit, which strikes the eye of the visitor immediately upon entering the gallery, is a model of a two-decker omnibus, supported on a top of a pitprop. A descriptive card states that the pitprop can support a load equal to a full-size omnibus of the kind shown—a weight of about 12½ tons.

Another section is devoted to the resistance of timber to abrasion. Flooring blocks of various woods are shown, the object being to illustrate the appearance before and after testing. An exhibit designed to drive home the wearing capabilities of various woods consists of a collection of jars containing the dust worn off them after each had been subjected to a standard test.

One of the most detailed sections of the Exhibition is that devoted to the structure of wood, which is shown by a number of photographic enlargements, among other methods. Particularly interesting is a series of cubic photographic models of Scotch-pine, beech and mahogany enlarged to 30 times their normal size. There is also a series of photomicrographs of various woods designed to show their structure.

A display that is sure to attract visitors is that touching on the buoyancy of different woods, and, consequent on that, on their weight. A block of lignum vitae is ranged on one side of a pair of balances against a number of blocks of balsa wood. The difference of volume representing the same weight is clearly shown. Another exhibit in this section demonstrates two methods by which the properties of wood are examined microscopically. A series of maps, photographs and specimens complete the collection.

Other sections are devoted to shrinkage and distortion of timber, demonstrated by various examples, and to timber seasoning, which is shown by means of photographs. In connection with this subject there is a small-scale model of an overhead internal fan-kiln and a series of photographs showing moisture content of timber and various methods of drying.

Film on Timber Subjects

A simple apparatus used for the butt treatment of fence posts and joists is included in the section devoted to methods of applying preservatives. Besides this there is a small-scale model of a pressure creosoting plant and steeping tank. The apparatus in connection with the butt treatment, by the way, is the actual apparatus used in a short film devoted to that subject which will be shown at the Exhibition. There are two projectors in the room, and these will be used to show various films made at Princes Risborough dealing with dry rot, the death watch beetle, fire resistance tests, and so on. This might literally be called a continuous performance, for the films are being shown all through the day.

An important twin section is that devoted to damage by fungi and by insects. A number of pieces of wood affected by dry rot are shown, and also examples of brown oak and green oak, both of which are coloured by fungi, compared with ordinary oak.

In addition to the three well-known insect borers, the death-watch beetle, the lyctus, and the furniture beetle, a feature is made of two others that are not so generally recognised. The first is the house longhorn beetle, which lays its eggs in the wood in a similar manner to the other borers. Incidentally, Mr. Donald told our representative that the Forest Products Research Laboratory would be glad to hear of instances of attack by the longhorn beetle. Its activities have come under notice increasingly of late and the laboratory is anxious to investigate the matter further. The other insect borer is the sirex wood wasp, which lays its eggs in the wood.

Heat insulation is well treated, and this is something new to exhibitions. Side by side models are shown of an ordinary hollow wall, one section plastered, and the other panelled. Beside each is a heap of fuel showing the comparative amount needed to reach a set of temperature in both cases: it is clearly shown that panelling has the greater power of retaining heat.

The section of research in woodworking is one that will especially interest the saw miller. By a series of specimens the importance of accurate setting and the necessity of obtaining a correct cutting angle are shown. An example each of a planing and moulding machine and a variety turner is included.

TIMBER IN COMMERCE

The foregoing exhibits have been concerned chiefly with the properties of wood. It has been the task of the Timber Development Association to attend to the commercial side. The chief exhibit that strikes the visitor on entering the gallery is the large specimen of Lamella roofing, which was erected by the Merchant Trading Co., Ltd. The Lamella system has already been illustrated and described in these columns, and visitors to the Exhibition will be able to see an actual example of the work, and to appreciate the virtues of this modern method of roofing. Under this roof are grouped the majority of the T. D. A. exhibits. Visitors to the recent Public Works Exhibition saw some of the T. D. A. exhibits now shown at the Science Museum—sections and models of timber houses—but a novelty to many will be the exhibit of timber connectors which, though used abroad for constructional work, are not as yet widely known in this country.

Another section arranged by the T. D. A. is that showing derivatives of wood. A striking background is made of patterned rayon fabrics. Besides these the relationship of rayon to wood—*via* spruce chips, xanthate, cellulose, alkali and viscose—is shown. Other derivatives featured are photographic roll-films, sausage casings (both from sulphite pulp), chocolates, glucose, molasses, cellophane, plastic wood and twine, to mention only a few.

The above survey of things to be seen at the Exhibition does little more than serve as a general indication of the show. Visitors will find—and a very helpful feature too—that copious descriptions are applied to each exhibit. It is an Exhibition to visit—well planned, well arranged, thoroughly informative, and holding great promise of leading the crowds who will see it to a new and a fuller conception of the wonders of wood and its service to mankind. Moreover, visitors will be impressed by the abounding evidence of the increasing attention that is paid to the important work of research in the timber field.

The Exhibition is open daily until February 6th, excepting Christmas Day.—(*Timber Trades Journal, 18th December* 1937.)

FIRE-RESISTING PROPERTIES OF TIMBER

DEAR SIR,—I have read with interest the extracts in your issue of October 23rd from the paper read by Captain L. Maruelle, of the Paris Fire Brigade, at Cheltenham.

Referring to the last paragraph of your article, the following quotation from a report of the Forest Products Research Board, Princes Risborough, about two years ago, may be of interest to your readers, and to Capt. Maruelle:

"*Fire Resistance Test*.—The laboratory testing of fire-resistance of timber has been investigated on a small scale, and several methods of testing have been tried out. The method finally adopted consists of measuring the time taken for a standard blow-lamp flame to penetrate a board of standard size, conditioned in air at a uniform temperature and humidity. This test has given fairly consistent results in preliminary trials, and distinct differences in the natural fire resistance of different species have been recorded. For example,

the time taken to penetrate a ½ in. board of teak was nearly twice that for oak and over four times that for Western cedar."

So that, while the fire-resisting quality of oak is high, I may claim, on behalf of the shippers of Burma teak, that teak in this respect is nearly twice as good.—W. C. LELY.

["*Timber Trades Journal,*" 30th *October* 1937]

CHEMICALS FOR PRESERVING WOOD

The heavy demand for creosote oil and other coal-tar products has resulted in an increase of prices which has made the manufacturers of wood preservatives look for other materials which can take their place. Inorganic products, like copper sulphate, zinc chloride, mercuric chloride, and sodium fluoride, have long been in use, but they could never compete successfully with creosote. Recently, however, some of these inorganic products have been improved considerably, with the result that they are now used on a larger scale. It is, for instance, reported from the United States that zinc chloride emulsions have met with some success and are now being applied, sometimes together with petroleum oils. The timber is first treated with a solution of zinc chloride and then with petroleum oil. In Australia and *India* impregnation has been carried out with a solution of *sugar* or *molasses* to which arsenic is added, but this process does not seem to be suitable for the English climate. Compounds of sodium fluoride and dinitrophenol have been used in considerable quantities for mine timbers.—[*"Manchester Guardian," Commercial Review, 19th November 1937.*]

INDIAN TIMBER INDUSTRY—TREATED INDIAN TIMBERS FOR ENGINEERING STRUCTURES

By S. Kamesam, M.I.E. (Ind.),
Timber Development Officer,
Forest Research Institute, Dehra Dun.

Recent important developments in timber engineering and preservation have been responsible for placing the most modern structural material at the disposal of the Indian engineer. The introduc-

tion of new types of efficient timber joints and the availability of cheap and universal facilities for antiseptic pressure impregnation of Indian timbers are two factors that have wrought a great change in the outlook for heavy timber construction in India. The change is almost as dramatic as the change from cast iron to steel, and clay mortar to modern cements during the nineteenth century. Timber engineering is now a science so that timber design cannot be left to carpenters any more.

STATIC SCIENCE

The time is past when wooden members were designed empirically. Now the stresses developed in such members are determined by the science of statics, and they are designed accurately with neither an excess nor loss of strength. It can now be guaranteed that all the parts of a wood structure are equally safe. It is now no more necessary to use only perfect grades of timber or absolutely straight-grained timber free from knots. The results of recent research have shown that it is unnecessary to import into India foreign woods for any structural purpose.

PROPER PRESERVATION

Properly preserved wood is as different from raw untreated wood as tanned skin is from raw hide. Efficient antiseptic impregnation has made it possible, with practically any timber, to realise a durability life which synchronises, even in the most severe conditions of outdoor location, with the economic life of engineering structures. A minimum service life of at least 25 years can be confidently expected. In sheltered locations, pressure-treated wood can last almost indefinitely.

TENSIONAL STRENGTH

As regards strength, there has been hardly any doubt among building engineers if timber is used in pure compression or tension. A $7\frac{1}{2}$ inches by $9\frac{1}{2}$ inches chir pine column 10 feet high has a safe supporting load of 69,000 lbs. and weighs 172 lbs. A 6 inches by 6 inches 18-lb. steel H column 10 feet high can support the same safe load as the timber column but weighs 180 lbs. A 3 inches by 8 inches chir pine tension member such as employed in a bridge or roof truss can resist a safe load of 31,000 lbs. and it weighs less than 6 lbs. per running foot. Two steel angles $2\frac{1}{2}$ inches by $2\frac{1}{4}$ inches

with a section of 1.8 square inch have practically the same tensional strength but weigh over 7 lbs. per running foot. The above examples are sufficient to illustrate the intrinsic strength of even one of the weakest of Indian timbers. As regards strength, stiffness, toughness, texture, appearance and hardness, wood offers a range of selection unrivalled by any competing building material. The reason for its not having been used in the past for engineering structures has been mostly due to the impossibility of obtaining, with available connection methods, more than 50 per cent. to 60 per cent. of the allowable working loads for members in framed structures. There was insufficient information regarding the strength of bolted joints.

IMPACT ALLOWANCE

A too high or unscientific factor of safety was used for deriving the working stresses of Indian timbers The fact that no impact allowance (for impact even up to 100 per cent. of loads figured) need be applied to working stresses for timber was not appreciated. It is hardly known to engineers that the strength of round timber is greater by about 18 per cent. than that derived by ordinary engineering formulæ. The fact, derived from numerous tests, that sound sapwood of any timber is just as strong as its heartwood remains still to be appreciated. In fact, as sapwood can be almost invariably preserved better, it should be preferred to heartwood, where preserved timber is employed. It is not widely known that the strength of any wood is, for all practical purposes, proportional to its specific gravity so that, weight for weight, the strength of wood remains about the same for all species of timbers.

WOODEN BEAMS

The "two-beam" action that occurs in wooden beams has only been recently discovered. This principle makes box-heart beams and joists useful, and it permits, in some cases, a saving of 40 per cent. of the material required according to former ideas regarding distribution of shear in beams. The practical significance of this discovery is very important as the sizes of wooden beams sanctioned under the new principle are easily obtainable and lead to a more efficient utilisation of Indian timber resources. In former practice, compression members were often seated on wood and their capacity was therefore limited by the much lower compressive strength of wood perpendicu-

lar or at an angle to grain. The introduction of what are called modern connectors has now made it possible to realise the full working strength of Indian timbers, besides making it possible to fabricate heavy timber structures with ease, rapidity and accuracy employing machinery. The high technical skill of the experienced carpenter is now eliminated.

Modern Connectors

Modern connectors which have been responsible for the most efficient timber joints, are essentially dowels developed to a high degree of efficiency. They consist of rings, plates or discs which are embedded in the faces of members to be joined and are held in position by a central bolt. Being embedded in wood, they distribute the load over a much greater area than a comparatively thin bolt does. Practically the strength of the whole area of the cross-section of a timber member can be developed. Their use has definitely passed the experimental stage and several thousands of them have been used in central Europe and America. The ordinary bolted tension connection can develop only about half the safe working strength of timber. The use of connectors makes it possible to use properly designed built-up members from comparatively thin planks instead of using solid heavy sections. Further, by using suitable connectors, indirect stresses due to eccentric connections in fabricated structures are avoided. The designer can be certain that each member in a truss is either in tension or compression and that there is no bending. For a tropical country like India there is another special advantage that requires mention. With ordinary bolted joints, a single split through the bolt hole seriously jeopardises its strength. This is not the case with a connector-joint where a large surface of contact and pressure functions. In view of these advantages that connectors confer, it is now possible to use timber in smaller sizes and of lower mechanical strength than what was formerly considered necessary or imperative for heavy engineering structures. The more slender appearance that is rendered possible by the use of connector built-up sections has a special appeal to architects. In the case of prefabricated structures or where quick erection and dismantling are required, the modern connector is a great advantage. Such structures have an extensive field of use as centering for

reinforced concrete bridges and buildings, in military work relating to portable bridges, barracks, and also in civilian work such as for derricks, exhibition halls and several other purposes.

TRUSTY TIMBER

Highway bridges, roof trusses, radio look-out water and transmission towers and many other heavy engineering structures, for which steel was exclusively considered before, are a few important fields where treated Indian wood, joined together with modern connectors, can cut down initial and ultimate costs of structures considerably. In these days of new broadcasting stations, because of the non-magnetic nature of wood, there is a good field for all-wood radio towers. In Germany, several wood radio towers have been built and a considerable saving of electrical power in transmission is claimed for this type of construction. Textile mills, chemical factories, wood and metal workshops, aeroplane hangars, harbour godowns, railway and commercial warehouses, exhibition halls, music halls, cinemas and theatres, gymnasia, athletic stadia, locomotive sheds, railway platform sheds are a few of the engineering fields in which treated timber-framed structures can be installed with advantage and economy. In this connection, it may be stated that actual tests initiated by the author have shown that rings of hollow bamboo and plugs of solid bamboo have great potentialities for use as modern connectors in India, especially for moderately heavy engineering structures such as roof trusses. As regards the relative weight of timber and steel-framed structures, an example may be cited. A 60-foot Fink type of roof truss built up with modern connectors using chir pine, weighs about 2,700 lbs. A steel truss of the same span, rise, and loading, weighs 2,800 lbs.

APPARENT ADVANTAGES

One of the great advantages that this modern connector type of construction offers is that it bids fair to develop a class of firms and fabricators similar to steel fabricators, who have established their workshops in all important Indian towns. A group of concerns that will fabricate framed wood structures and treated timber, serving as a link between the producers of raw timber and building contractors, is a development in Indian structural practice that has a great field of national service. It is hoped that large builders of

structures like the Railways and the Public Works Departments will specify the use of treated wood employing modern connectors instead of steel structures.

SPECIFIED TIMBERS

A list of the more important Indian structural timbers that deserve the attention of the engineers is given below. Their working stresses can be obtained on application to the Utilisation Officer, Forest Research Institute, Dehra Dun:

1. *Anogeissus acuminata*
2. *Anogeissus latifolia.*
3. *Calophyllum* (species).
4. *Cedrus deodara.*
5. *Heritiera minor.*
6. *Homalium tomentosum.*
7. *Lagerstroemia lanceolata.*
8. *Mesua ferrea.*
9. *Pinus excelsa.*
10. *Pinus longifolia.*
11. *Pterocarpus marsupium.*
12. *Shorea robusta.*
13. *Tectona grandis.*
14. *Terminalia bialata.*
15. *Terminalia paniculata.*
16. *Terminalia tomentosa.*
17. *Xylia xylocarpa.*

Several aspects of the subject that have been dealt with in the present article have been presented by the author in a more detailed manner in eighteen timber development booklets that have been published by the Forest Research Institute, Dehra Dun. Any or all of these booklets can be obtained *gratis* on application to the Timber Development Officer, Forest Research Institute, Dehra Dun.

PERSEVERING PROGRESS

In these times of rapid engineering progress and constant change in the human outlook as regards comfort and æsthetics, the theory of "direct benefits" has definitely superseded the "ability to pay" theory as a basis for assessing the ultimate utility and economy of structures. Building for permanence must yield its place to scrapping

or modifying structures for economy and efficiency. Treated timber is the ideal building material based on this criterion. Increasingly, in the near future, it will be the experience of engineers and administrators that structures built to the highest of prevailing standards will have become in two or three decades a hazard to their users and a headache to their administrators. Unfortunately, highway bridges, railway station buildings and other structures are quite susceptible to excessive obsolescence because no competitors are available to illuminate the inconvenience or the excessive operating costs involved. But, despite this, the process continues, and those who aim at the maximum of public economy should make sure that no false economy or respect for tradition is permitted to thwart their judgment in the selection of structural materials.

Compelling Comparisons

In these days of extensive research, the economic or mechanical permanence of most structures cannot be reckoned to be much over 25 to 30 years, a period which usually synchronises with the minimum life of properly treated timber under the worst conditions. Even assuming that the life of a steel or concrete structure as limited by mechanical obsolescence or chemical factors is as high as 60 years, and if the average life of a corresponding structure of treated wood is assumed to be only 25 years, a simple arithmetical calculation will show that for equal ultimate economy (neglecting several minor factors) the steel or concrete structure should not initially cost more than about one and a half times the cost of the wood structure. Based on this criterion, an engineer can easily see, by himself working out the estimates, that only in very few cases indeed can steel or concrete compete with treated wood.—*"Indian Engineering," Special Supplement, December* 1937.

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India*, for December, 1937:

IMPORTS

ARTICLES	MONTH OF DECEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
Siam ..	36	55	79	3,744	6,092	12,700
Burma ..	..	..	14,154	..	..	18,75,460
French Indo-China ..	..	..	104	..	..	12,515
Other countries ..	..	501	137	..	51,205	18,142
Total ..	36	556	14,474	3,744	57,297	19,18,827
Other than Teak—						
Softwoods ..	1,142	654	2,808	56,529	37,269	1,69,553
Matchwoods ..	..	916	717	..	57,855	49,354
Unspecified (value) ..	..	..	..	1,35,458	21,169	2,80,493
Firewood ..	10	28	36	100	420	540
Sandalwood ..	2	14	10	1,728	6,744	1,489
Total value ..	..	..	..	1,93,815	1,23,457	5,01,429
Total value of Wood and Timber ..	..	..	..	1,97,559	1,80,754	24,20,256
Manufactures of Wood and Timber—						
Furniture and cabinet-ware ..		No data			No data	
Sleepers of wood ..	..	..	4	..	..	511
Plywood ..	..	238	383	..	61,085	94,881
Other manufactures of Wood (value) ..	..	..	..	2,04,352	1,55,829	1,00,511
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,04,352	2,16,914	1,95,903
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	21,597	21,104	19,281	1,48,960	1,42,395	1,36,164

EXPORTS

ARTICLES	MONTH OF DECEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1935	1936	1937	1935	1936	1937
WOOD AND TIMBER						
Teakwood—						
To United Kingdom ..	3,434	4,182	..	6,52,698	8,64,921	..
" Germany ..	177	691	..	37,088	1,83,756	..
" Iraq ..	87	36	48	11,174	6,262	3,160
" Ceylon ..	102	205	..	12,175	21,867	..
" Union of South Africa ..	175	1,009	..	28,698	2,17,370	..
" Portuguese East Africa ..	197	287	..	29,958	49,965	..
" United States of America ..	..	..	..	..	..	..
" Other countries ..	324	989	144	71,908	2,12,960	41,657
Total ..	4,496	7,399	192	8,43,699	15,57,101	44,817
Teak keys (tons) ..	368	351	..	55,125	51,267	..
Hardwoods other than teak ..	67	30	..	6,700	3,000	..
Unspecified (value) ..	..	..	..	15,296	1,69,496	90,545
Firewood	1	..	1	11	..	8
Total value ..	..	..	..	77,132	2,23,763	90,553
Sandalwood—						
To United Kingdom ..	15	..	..	15,656	..	..
" Japan ..	12	12	..	13,540	15,727	..
" United States of America ..	65	2	2	65,000	1,600	2,500
" Other countries ..	6	15	27	7,010	19,392	29,195
Total ..	98	29	29	1,10,206	36,719	31,695
Total value of Wood and Timber ..	..	..	..	10,22,037	18,17,583	1,67,065
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)..	..	..	..	5,085	18,691	34,246
Other Products of Wood and Timber ..	No data			No data		

INDIAN FORESTER

APRIL, 1938.

SUCCESSION IN PLANTATIONS OF LIGHT CROWNED SPECIES

BY E. A. SMYTHIES, I.F.S.

Abstract.—Plantations of light crowned species in the United Provinces invariably show rapid invasion of shade-bearers. It is suggested that future management should bear this in mind, and possibly introduce shade bearers of economic value.

A natural succession of shade-bearers in *shisham* (*Dalbergia sissoo*) crops, both plantation and natural riverain, has long been recognised. The classic example is, of course, Changa Manga, where water-borne mulberry invaded the established *shisham* crops in the first rotation, and led largely to the expansion of the sports industry. In my note on the Miscellaneous Forests of the Kumaun Bhabar (*Indian Forest Bulletin*, No. 45 of 1920), I recorded and illustrated the invasion of riverain *shisham* by *Holoptelea*. The object of this brief note is to suggest that in protected plantations of light crowned species, a natural rapid succession of shade-bearers is not only probable but almost inevitable, and to emphasise an important lesson in future management of such plantations, which follows from this phenomenon.

2. During the last 20 years, plantation work has expanded enormously in the United Provinces, and there are now many examples of *shisham*, *khair* (*Acacia catechu*) and *babul* (*Acacia arabica*) scattered about the province, both in forest tracts and in the plains districts far removed from forests, and some of the more instructive examples may be noted.

A. *Plains plantations.*—(*i*) The Allenbagh, Cawnpore. About 250 acres, started in 1915 and completed in 1917, with sowings of *shisham* and *babul*. The invasion of this successful plantation is

A

now practically complete, the principal invading species being *jaman* (*Eugenia jambolana*), and *nim* (*Melia indica*), the seeds of which have obviously been brought by birds from trees in the surrounding *zamindari*. These species now form a complete under-storey, particularly below the *shisham*.

(*ii*) The Improvement Trust, Lucknow. A similar but somewhat younger plantation (1922—25) of *shisham* and *babul*, with rapid invasion going on, again chiefly of *jaman* and *nim*.

(*iii*) Clutterbuckganj research plantations, Bareilly. A number of different plots of various species and ages. The oldest are 1918 *shisham*, created by planting stumps (obtained from natural riverain seedlings of the *Bhabar* zone 60 miles away) and irrigating with hot and slightly resinous water from the turpentine condensers! There are two instructive plots side by side, both overstocked with *shisham* up to 50 feet high, one plot open to grazing, the other closed. The former has a bare floor (except for light grass), the latter has complete invasion by a variety of species, including *gutel* (*Trewia nudiflora*), which must have been introduced, since it does not, so far as I know, occur in this locality at all.

The next oldest plot is mixed *shisham* and *babul*, created by patch sowings about 1922—24. Here an astonishing variety of species are to be found in the rapidly developing under-storey, including profuse *babul* natural regeneration, mulberry, *jaman*, *nim*, figs, *Ehretia laevis*, *Holoptelea* and even guava and mango!

Several younger plots of *shisham*, *khair*, and *babul*, created about 1930—32 by *taungya*, show invasion of shade-bearers already beginning. A 6-year-old *khair* plot has been very successfully underplanted with *jaman*.

In all the above examples, the invasion has, fortunately for us, been predominantly of valuable species, and the principal agency has obviously been fruit-eating birds.

B. *Forest plantations*.—I propose to give three examples, where the invasion has, unfortunately for us, *not* been of valuable species:

(*i*) *Shisham* plantations near Haldwani, 1920 to 1930 period, on dry infertile Bhabar soil infested with *lantana*. The *lantana* was eradicated when the plantations were made, but has again invaded

the area under the *shisham*, to the exclusion of any more valuable species.

(*ii*) *Khair* plantations near Lalkua, created by Howard in 1928-29. The whole area has been densely invaded by *Mallotus philippinensis*, again to the exclusion of anything more valuable.

(*iii*) Another *shisham* plantation in Lansdowne division shows a dense undergrowth of *Murraya keonigii*.

In these three cases, the ground was originally occupied by the species which now form the under-storey. Generally speaking in forest plantations (as opposed to *taungya*) the ground is already occupied by something which greatly increases the difficulty of controlling the succession.

3. We can, I think, take it as established that plantations of light crowned species such as *shisham, khair, babul, etc.*, protected from fire and grazing, will almost inevitably be rapidly invaded by one or more species of shade-bearers, the ease and universality of this phenomenon is sufficient proof.

In the past, we were concerned chiefly in the successful creation of the first crop, and did not trouble about possible invasions and successions, but the time has now arrived when we must think a stage further, and take full advantage of this inevitable phenomenon. If a succession of shade-bearers is coming anyway, I suggest we should see to it that they are of economic value, and not worthless weeds like *lantana* or *Mallotus*. In fuel and fodder plantations, such as the Saharanpur *taungyas*, the introduction of shade-bearing fodder species is indicated, such as mulberry, the *Terminalias, Bauhinias*, possibly *Ougeinia*. In timber or *katha* plantations, *jaman* is an obvious possibility on suitable soils, also perhaps mulberry, which fails from excessive branchiness as a primary crop, but appears to be much less branchy grown under shade. The ease with which these shade-bearers appear in nature suggests that no great expenditure would be required. In *taungya* plantations, throwing seed broadcast immediately the cultivators leave an area should suffice, but in forest plantations this simple procedure would not succeed. The idea seems to deserve more consideration than it has received in the past, bearing in mind that ordinary forest plantations are a different problem to *taungya* plantations, or plantations in the plains districts.

OBSERVATIONS ON THE GROWTH OF POECILONEURON INDICUM

BY KADAMBI KRISHNASWAMY, D.SC., A.C.F., BANGALORE

Vernacular names:—Kanarese: *Balagi, Baliga, Ballagi, Kirballi, Balige, Bluina;* Tamil: *Puthan-kolli, Pathang-koli;* Malayalum: *Vayila, Puthankalli,* etc.

Summary.—*Balagi* is one of the most important woods of the Ghat forests of Mysore. It has adapted itself very well to the extremes of ecological conditions prevailing in evergreen forests.

Two varieties of *balagi* exist in Mysore, which distinguish themselves from each other morphologically and anatomically. The heart-wood of one is dark red in colour and that of the other is nearly black.

The acuminately-tipped, smooth-surfaced leaf of *balagi* is well adapted to allow the rain water to readily run off its surface. The stilt roots of the tree save it from being dislodged from its position on the steep hill slopes. The leaf of the seedling is shade-bearing, while that of the adult tree is thick cuticled and constructed to prevent excessive transpiration. The dome-shaped crown and rapid apical growth permit the tree to stand the competition for light.

Having been in charge of the forest operations in the evergreen forests of Mysore for two years, the writer had opportunities to make a few field observations on the growth and silvicultural characters of *Poeciloneuron indicum* or *balagi,* as it is commonly known in these parts, one of the most important woods of the Ghat forests which, in virtue of its hardness and capacity to develop clean, straight, cylindrical boles to considerable heights, has been used for the last 15 years, in lieu of steel poles, on the high power transmission lines in the State. *Balagi* is one of those species of the evergreen zone which has adapted itself to the peculiar extremes of micro-climatic and other conditions prevailing in such forests in a most satisfactory manner. Owing to its shade-bearing nature when young, its capacity for rapid height growth, the conical apiculate crown it possesses during early youth, which helps the young tree to make its way through the forest canopy into the higher storeys of vegetation in face of keen competition for space, and its beautiful, thick cuticled, glossy leaves which can efficiently resist the dessicating effect of the hot, dry atmosphere at the level of the forest crown, *balagi* is, at the same time, one of the most hardy and pretty among the forest trees dominating the evergreen forest canopy.

Habitat.—In Mysore the tree is a native of the evergreen forests of the Western Ghats of Shimoga and Kadur districts, from the foot

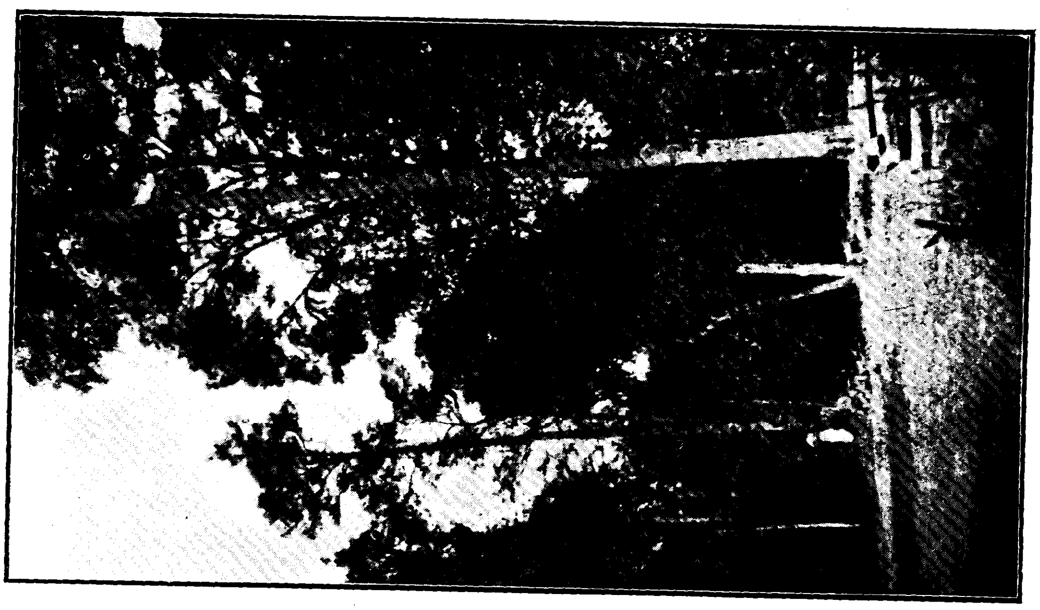


Fig. 1

Two trees of POECILONEURON INDICUM. The one in the background is about 112 ft. high. That in front shows the clean, straight bole which this species is able to develop

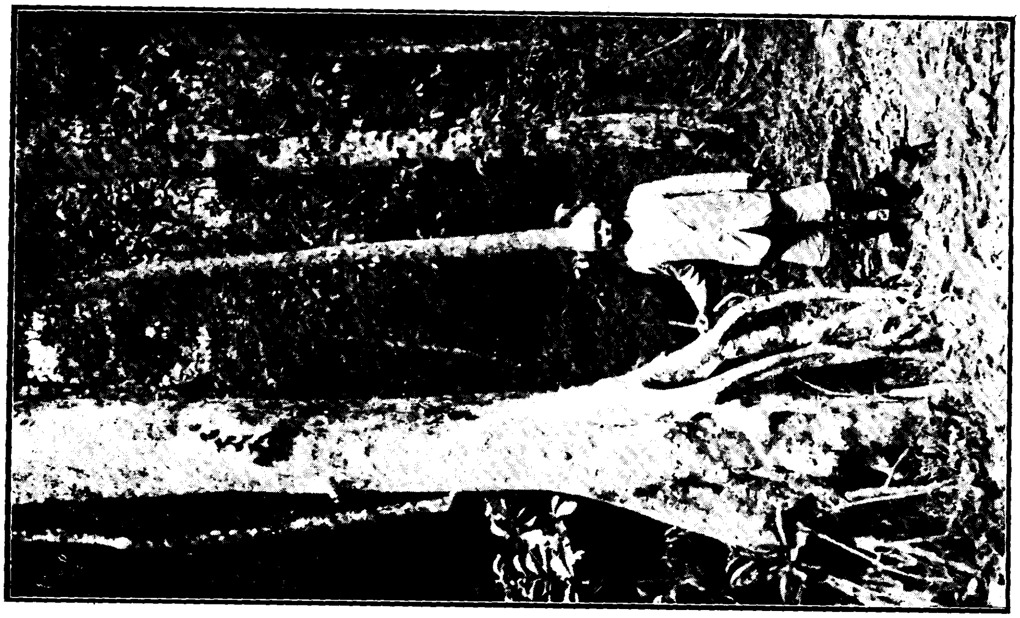


Fig. 2

View of the lower portion of the bole of an adult tree, showing the cylindrical bole raised typically on the stilt buttresses. The tree on the right is also BALAGI

of the Kodachadri Hills southwards up to the Bhadra River valley, which is the richest tract. Between Kodachadri and Gersoppa it is very sparse, being found in isolated patches. The following is a list of State forests where *balagi* is commonly found, and their areas. Commencing from the north they are:

			sq. m.
1.	Govardhanagiri	... ...	45.3
2.	Karni	... ...	28.5
3.	Kodachadri	... ...	8.1
4.	Chakra	... ...	3.5
5.	Kilandur	... ...	25.5
6.	Varahi	... ...	9.97
7.	Manibyle	... ...	2.71
8.	Agumbe	... ...	20.17
9.	Balehalli	... ...	8.27
10.	Narasimhaparvata	... ...	26.61
11.	Tungabhadra	... ...	77.87
12.	South Bhadra	... ...	34.63
13.	Balur	... ...	31.46
	Total	... ...	322.59

It thrives at heights varying from 1,000 to 3,000 feet above sea level. and is generally confined within Mysore to a thin belt of evergreen vegetation five to six miles broad along the crest of the Ghats. It also descends over the Ghat Head into the adjoining forests of South Canara, where it is abundant on the steep Ghat slopes facing the Arabian Sea. Mr. Foulks states that in South Canara the tree is found mostly in certain sharply defined patches. Bourdillon mentions it as common in the south of Travancore at elevations of 1,000 to 3,000 feet, but less so in the north where it is generally found in clumps growing on wind-swept ridges. Troup observes that it grows more or less gregariously, sometimes forming almost pure crop. Grass records

the following results of countings made in 1898 in three plots of one acre each:

Plot No. 1	...	158 trees varying in girth from	1′ to 10′.
„ „ 2	...	291 „ „ „	1′ to 6′.
„ „ 3	...	79 „ „ „	1′ to over 6′.

(Plot 1 was in Mysore and the other two in South Canara.) In Mysore the tree is hardly ever gregarious in the typical sense of the term, but usually occurs mixed with *Dipterocarpus indicus*, *Mesua ferrea*, *Dichopsis ellipticum*, *Mastixia arborea*, *Callophyllum elatum*, etc. It usually prefers hill slopes to flat land and attains its best heights on the wind-swept row of hillocks facing the Ghat Head.

The following figures extracted from the records of valuation survey in the Agumbe and Balehalli State forests, which lie in one of the richest *balagi* tracts of Mysore, indicate the number of *balagi* trees per acre of forest:

Locality. Compt.		Area enum-erated. Acres.	GIRTH CLASSES IN FEET						Total.	No. of trees per acre.
			1 to 1½.	1½ to 3.	3 to 4½.	4½ to 6.	6 to 7½.	Over 7½.		
Agumbe Forest No.	1	.. 20·5	233	153	143	93	42	12	676	33·0
„	2	.. 17·5	219	115	35	21	11	5	406	23·2
„	5	.. 18·0	233	141	68	47	12	9	51)	28·3
„	6	.. 15·0	328	176	124	32	9	4	673	45·0
„	7	.. 33·7	514	229	99	68	6	10	926	27·5
„	10	.. 34·5	395	151	118	79	28	6	777	22·5
Balehalli Forest No.	1	.. 21·75	233	153	143	93	42	12	676	32·4
„	2	.. 26·75	172	137	90	75	16	12	502	19·1
„	3	.. 27·00	120	108	68	67	9	12	384	14·2
„	6	.. 24·75	156	100	57	12	11	1	337	13·6
„	7	.. 35·25	361	151	115	33	22	16	698	19 8

It will be seen from the above that the number of trees per acre, even in very good *balagi* areas, is much smaller than that found by Grass.

General morphological description.—*Balagi* is a large evergreen tree with a clean, straight bole which attains a girth of 8 to 10 feet or more at breast height and a height of 120 feet or over (see Figure No. 1). The sapwood contains a yellow thick juice which is a general characteristic of the family *Guttiferae* to which the tree belongs. The crown is at first roughly conic-cylindrical, resulting from the continued activity of the apical shoot for a long time. This enables the tree to reach great heights and develop long, comparatively thin, cylindrical, unbranched boles. When the tree has reached the top storey of the vegetation, the crown generally spreads itself laterally and assumes more or less the shape of an umbrella. A very characteristic feature of this tree and one which readily distinguishes it at first sight from others in the forest is the presence of stilt-shaped buttresses at the foot of the bole. These start generally at heights of 2 to 5 feet from the ground level, often as the aerial roots of a banyan tree do form its branches, and descend downwards to the soil describing a curve roughly at an angle of 45° from the vertical axis of the standing tree, and strike root. The growing tips are provided, as in the banyan tree, with conspicuous, reddish brown root-caps. The trunk of a well-grown tree looks as if supported on a number of arched legs reminding one of the genus *Pandanus* which is also a native of these forests. From a distance the bole appears as if raised from the surface of the ground and supported on props, consequent on the soil having been washed away from around the roots (see Figure 2). In old trees the stilts get flattened out into a more or less typical plank-buttress shap (see Figure 3). The bole is cylindrical above the level of the buttresses (see Figure 2).

The bark varies from dark brown to dark grey in colour. In the mature tree the remnants of dead branches are often found overgrown by fresh woody tissue, making the timber defective.

Leaf, Flower and Fruit.—The leaves are opposite, exstipulate, smooth and coriaceous, with an indefinite number of equidistant, close set, almost parallel, lateral veins. The veins are not prominent. The lateral veins are joined at right angles by numerous, less conspicuous transverse ones. The leaves are also petiolate, elliptic-acuminate and measure 4 to 10 inches by 1½ to 2½ inches. The copious, yellowish white flowers are placed in pyramidally spreading, terminal panicles which are 4 to 5 inches or more long. They are

hermaphrodite, sweet scented and about $\frac{3}{4}$ inch in diameter. The calyx has 4 to 5 imbricate sepals. The corolla consists of 5 to 6 petals and is contorted or imbricate in bud. The stamens number 16 to 20 and are free or slightly connate at the base. The filaments are short or absent; the anthers are basifixed, narrow-linear and erect. Each anther cell consists of numerous superposed compartments. The peduncles, pedicels and sepals are slightly puberulous. The ovary is superior, two celled, with two filiform styles and two ovules in each cell, which are ascending from the base. The fruit is an ovoid capsule, 1 to $1\frac{1}{2}$ inches in diameter and is one celled. It dehisces septicidally, and has a single, erect, exalbuminous seed. The cotyledons are fleshy; the radicle is minute and inferior.

The flowers appear during December and last till March. During the height of the flowering season, which covers the latter part of January and the first half of February, the atmosphere in the interior of the forest is often filled by a sweet scent emanating from the innumerable pretty panicles of *balagi* flowers. The fruits ripen by July and the seeds start germinating in August. The growth of the seedling is at first rapid due to the large amount of food material stored up in the fleshy cotyledons. The radicle develops a tap root 6 inches or more long, and the young seedling reaches under favourable conditions a height of half a foot or more within a fortnight. Later on the growth is slow.

The Wood and its uses in South India.—The wood is usually dark red, smooth, rather dull and almost straight-grained. Occasionally trees with zig-zag, very coarse grain are found. Its specific gravity according to Pearson and Brown is 0.86. According to Kann, the weight per c.ft. of air dry wood is 66 lbs., but the wood of the "black variety" of *balagi,* to be presently mentioned, is distinctly heavier. Air-seasoned wood of this variety was found to weigh $69\frac{1}{2}$ lbs. per c.ft.

The wood is used for building purposes and for rice pounders in some parts of Mysore, Malabar and Travancore. Troup states that it has given satisfactory results as a sleeper wood on the Madras Railway where sleepers laid down in 1899 stood fairly well up to 1907. Half moon shaped sleepers prepared at Bhadravati, in Mysore, are being laid on the tramlines for the last three years and are doing

quite well. The most important use, however, for this wood is as poles for the electric transmission lines. Treated poles are being used in this manner for the last 10 years. The wood is also said to be suitable for paving blocks (Troup).

Varieties of Poeciloneuron indicum in Mysore.—It has been observed for a long time that two varieties of *Poeciloneuron indicum* exist in the Mysore forests which distinguish themselves morphologically and anatomically. One has heartwood of dark red colour and the other has it nearly black, suggesting that of the well-known ebony (*Diospyros ebenum*), also a native of these forests. The floral characters of both agree generally in every important respect, so that no grounds exist for separating them on the construction of the reproductive parts. The only difference, and that a minor one, is that the panicles are borne on shorter stalks in the black type. The trees of the two kinds, however, show certain characteristic morphological differences which help in distinguishing them from each other, and these are detailed below. For purposes of description the two varieties will be called the "dark red type" and the "black type" respectively.

1. The bark, main branches and twigs are distinctly darker in the black type than in the other.

2. The leaves of the adult tree of the black type are generally smaller, $\frac{1}{2}$ to $1\frac{1}{2}$ inches less in length and proportionately also in breadth, and possess darker green tint. The lateral veins are less prominent, as also the transverse ones.

3. A tree of the black type is more conspicuously branched. The main branches emerge at a lower level from the bole, and are generally stouter and more pronounced than in the other.

4. Trees of the black type do not generally grow to the same height as the other in the same locality but are shorter.

5. The formation of heartwood sets in earlier in the black type. The presence of a distinct central core of heartwood can be made out in a five to six years old seedling of this type. In the dark red type, the heartwood does not differentiate itself from the sapwood till the seedling is 10 or more years of age.

6. In the black type, the transition from the heartwood to the sapwood is abrupt and sharp. In the other, the sapwood passes on more or less gradually to the heartwood.

7. The two types distinguish themselves also with respect to their habitat. The black one tolerates a comparatively shallow poor soil and is more often found in areas where laterite outcrops at the ground surface or is found a little beneath it. In such localities the depth of soil capable of bearing plant growth seems to be generally insufficient for the dark red type. The former can also tolerate a certain amount of waterlogging or incomplete drainage. It is sometimes found on the edges of the natural blanks existing in the evergreen forests, a situation which is scrupulously avoided by the latter.

8. The wood of the black type is harder and heavier. Comparative weighing of air-seasoned wood of the two types got from the same locality showed a difference of 4 to 5 lbs. per c.ft.

9. A microscopic examination of sections of the two woods shows that the lignified cell walls of the heartwood are darker and thicker in the black type.

Adaptation of Poeciloneuron indicum to the prevailing growth factors in evergreen areas:

1. *Temperature*.—In the Ghat evergreen forests of Mysore, where the prevailing mean annual temperature could be taken as the optimum for this species, the absolute maximum shade temperature varies from 90° to 98° F. and the minimum from 50° to 60° F. This is typical of the natural habitat of *balagi*. The rainfall varies within wide limits, from about 225 to 375 inches or more a year. Most of the rain falls, however, within a few months, between June and September. During the rest of the year comparatively dry conditions exist. During the rainy season torrential rains pour almost incessantly and rainfalls amounting to 19 inches within 24 hours are not quite uncommon. The sub-soil water rises almost to the ground surface and very large quantities of water rush out of every seam or chink in the ground, especially in uneven country. In the dry season, on the other hand, most of the forest streams run-dry and difficulty is frequently experienced even for drinking water. These extremes of moisture conditions assisted by the great porosity of the lateritic soil which abounds in these areas demands great hardihood from the vegetation.

Adaptation of balagi leaf to rainfall.—The ombrophilous, acuminately-tipped, smooth-surfaced leaf of *balagi* permits of the rain water readily running off its surface. The leaf surface remains

quite free from extraneous water even during the incessant rainfall so that the photosynthetic activity of the leaf proceeds unimpeded.

Adaptation of the tree to its situation.—As already stated the tree prefers the slopes of hillocks with steep gradients. Owing to this and to the strong western wind to which the crowns of trees are exposed, the tug on the root-system which is responsible for keeping the trees standing is very severe. The stilt buttresses adapt the tree excellently to meet this end. The stilts save the tree from being dislodged in spite of the wash-out of the soil from in between the roots caused by the heavy rainfall and the heavily sloping country. One frequently sees trees standing on very steep slopes (gradient 70° and more) raised 6 feet or more from the ground and supported entirely on the stilts. Owing probably to the continued wash-out in such places, the soil is often entirely devoid of any other vegetation.

Adaptation of balagi to the microclimatic conditions prevailing in the evergreen forests.—In every tropical forest, the temperature and humidity under the forest canopy are different from those at the level of the crowns or above them. Within the forest, there exists during most parts of the year an atmosphere charged with water vapour and sunlight hardly reaches the ground owing to the density of the vegetation. Consequently, the average air temperature is about 30° F. lower than in the open. Above the level of the crowns exist comparatively xerophytic conditions, especially during the dry season. The fierce rays of the sun shine upon the exposed leaf carpet formed by the forest crown which, when viewed with a pair of binoculars from an opposite vantage point, glistens through the mirroring of the sun's rays from the millions of tiny highly cutinised leaf surfaces. The air temperature rises not infrequently to 120°F. or more. The leaf of *balagi* is well adapted to meet these conditions. The seedling of this species which has to thrive under the forest roof is a moderate shade-bearer. An examination of the cross-section of a leaf of *balagi* seedling makes this point clear. The epidermis of such a leaf is comparatively thin and provided with a poorly developed cuticular layer. The palisade tissue consists generally of a single layer of cells and the spongy mesophyll is provided with ample air spaces. The stomata are placed at the level of the epidermis. On comparing such a leaf with one found in a full-grown *balagi* tree whose crown stands at the level of the forest canopy a hundred feet or more from the ground, the following differences in construction are observed:

1. The epidermis of the latter is provided with a thick cuticle, and the stomata are sunk below the leaf surface. The epidermal walls are also much thicker.

The palisade cells of the latter are arranged in more than one layer and are comparatively closer set.

3. The spongy mesophyll has few comparatively small air spaces.

4. The latter leaf has a tougher texture and a more shining surface.

Adaptation of the tree to the competition for light and space in the evergreen forest.—The young seedling, as mentioned above, has to thrive in shade and is therefore able to tolerate shade moderately well. The adult, on the other hand, is a strong light demander and is seen to succumb if overtopped by other forest trees. On passing from the thicket to the pole stage, the tree commences to demand more light and has consequently to adapt itself, as best as it can, to survive in the upward race for light. The pointed apex, which results from the continued activity of the principal apical shoot, enables the tree to make its way persistently upward through the dense mass of vegetation (see Figure 4). The diameter of the crown decreases owing to the comparatively limited scope for lateral expansion, but its length increases rapidly. The lower branches, which get shut out owing to the rapid upward growth of the stem apex, now die leaving behind dead knots and branches, which decay, are overgrown by sound woody tissue as the tree increases in girth, and cause characteristic defects in the timber. Once the tree has reached the top storey of the evergreen vegetation, the rapid height growth ceases, the crown commences to expand more or less horizontally and assumes the shape of an umbrella. The nutrition, which was so far almost completely consumed for the rapid height growth, is now diverted towards the growth of the stem in diameter, and this consequently puts on girth rapidly. The thin long bole assumes its adult proportions in a short time.

The seedling regeneration of balagi.—The thick layer of fallen dead leaves on the floor of the evergreen forest is one of the chief causes which tend to impede the establishment of young seedlings soon after the germination of the fruit. The presence of two thick cotyledons with sufficient nourishment enables the embryo of *balagi*

Fig. 3
A view of the buttresses in an old tree illustrating how the stilts are getting flattened out into the plank shape

Fig. 4
A young tree in its pole stage. Observe the pointed apex and the cylindrical crown. The larger tree facing the camera is AMOORA CANARANA and the thin, tall one to the extreme left is GARCINIA CAMBOGIA

to develop a long tap root which reaches down to the mineral soil through the fairly dense carpet of dead leaves. The plumule grows very rapidly in the earlier stages, nourished amply by the endosperm, and the first pair of leaves is, therefore, able to stand well above the humus layer on the forest soil, often attaining a height of 6 to 9 inches in a few days. *Balagi* seeds generally every alternate year, and as the quantity of seed borne on each tree is very large, its natural regeneration in the forests, especially in open areas, is extremely abundant owing to the intrinsic advantage the seeds possess for rapid germination and establishment in the form of a large quantity of easily assimilable food material stored in the cotyledons. It often happens that open areas caused by the extraction of *balagi* trees within the forest are often completely covered by germinating seedlings of this species. 200 to 350 seedlings in every 6 sq. ft. of space have frequently been counted by the writer. Not infrequently, the surfaces of the extraction paths are studded with multitudes of seedlings whose abundance astonishes any one who visits these spots. In the ensuing dry weather, a large number of these seedlings die away owing to the following adverse causes:

1. The seedlings suffer considerably from drought during summer, as they are generally found in exposed situations. The organic humus, at such spots, will have been disintegrated to a considerable degree owing to the continuous exposure of the soil to the sun.

2. At such spots, the rapid growing annuals and perennials which are usually the pioneers in the succession of vegetation in every forest, soon overtop the *balagi* seedlings which grow comparatively slower in their infancy. This results in the smothering and death of a good number of the latter. Among such pioneers are the wild cardamom, the wild turmeric, *Curcuma aromatica, Curcuma nilghirica, Alpinia galanga, Leea sambucina, Callicarpa lanata, Colebrookia oppositifolia, Macaranga roxburghii,* and not infrequently, *Pinanga dicksonii.* As some of these species are bad shade-bearers and do not generally attain any great heights, they are gradually overtopped by the pole growth of evergreen species like *balagi, Mesua ferrea, Dipterocarpus indicus, Dichopsis ellipticum, Amoora canarana, Mastixia arborea* and a host of others. When the forest has reached the final stages of succession the place of the

pioneer species, mentioned above, in the vegetation is occupied by shade-bearing trees like *Polyalthia cerasoides, Unona pannosa, Chailletia gelonioides, Psychotria truncata, Psychotria dalzelli, Humpboldita brunonis,* and a host of others. *Pinanga dicksonii,* which makes its appearance first along with the pioneer species, persists till the end and occupies patches of soil, often gregariously, among the underwood. The top and middle layers of the canopy are now formed by the following species, in addition to those mentioned above:

Calophyllum elatum, Elaeocarpus tuberculatus, Elaeocarpus serratus, Garcinia indica, Garcinia cambogia, Myristica magnifica, Dyospyros macrophylla, Bischofia javanica, Hopea parviflora, Canarium strictum, Artocarpus hirsuta, Lophopetalum wightianum, Holigarna arnottiana, H. beddomii, Aglaia odoratissima, Nephelium longanum, Schleichera trijuga, Dysoxylon malabaricum, Diospyros ebenum and such others.

The abundance of the seedling regeneration of *balagi* combined with the vigour with which this species is able to stand the keen competition for space and light which exists among the members of the growing stock indicates that it enjoys the optimum climatic and edaphic growth factors in these forests. The remarkable abundance of every age class in the mixed forest crop consisting of over a hundred tree species indicates the virility of this tree.

It is, however, necessary to assist the natural seedlings, especially when they are getting into the pole stage, in getting more sunlight from above by gradually opening out the canopy through felling or girdling trees in the top storey of the forest. Groups of natural seedlings, just getting into the pole stages, are very common in the forests and the competition for light, under which they labour, is also intense. By giving them more light at this stage the trees develop clean, tall, straight boles as could be witnessed in areas where large trees of *Dipterocarpus indicus* have been felled for sleepers in the past. In the very early years, the seedling regeneration of *balagi* is frequently smothered by dense growth of the annuals and other softwooded pioneers in the succession of vegetation. These competitors should be promptly removed after every seed year in forest openings where *balagi* seedlings have established themselves.

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WOODEN PIPES AND TANKS—A NEW FIELD OF TIMBER UTILIZATION

BY V. D. LIMAYE

Officer-in-Charge, Timber Testing Section,

Forest Research Institute, Dehra Dun.

Abstract.—Wooden pipes and tanks for water-supply are in use in America for a long time and giving very satisfactory service. The pipes can be made 2 to 60 inches in diameter and tanks anything up to 60 feet diameter and are used for various purposes such as municipal and domestic water-supply, mining, irrigation, etc. The pipes and tanks are built up of a number of wood staves machined on all the four sides so as to produce a perfect circle of the required diameter. In small pipes the staves are held together by tightly wound galvanized wire In the case of large pipes and tanks the staves are held together by individual steel bands.

The writer had an opportunity of visiting the workshops of the Canadian Woodpipe and Tanks Ltd., at Vancouver, B. C., while he was on deputation in Canada. This company has been manufacturing wooden pipes and tanks for over thirty years. The pipes range from 2 inches diameter for domestic supply to 60 inches for the supply of big cities like Vancouver. They are also made up to a diameter of 16 feet for big hydro-electric developments. The tanks may be anything up to 60 feet in diameter and a capacity of 3,00,000 gallons. He was so much impressed by the utility of this type of construction that he has written this note on the manufacture and uses of wood pipes and tanks with a view to interesting readers in

India, especially engineers and forest utilisation officers, and possibly helping to open up a new field of timber utilisation in this country. The plates are reproduced from the Company's publications.

Early wood pipes.—Although wooden pipes in their present form are distinctly modern products, similar pipes of simple design were in use several thousand years back. An outstanding example of early wooden pipes is that of the linings found in many deep artesian wells in the Libyan Desert in Egypt. They are said to be still in a remarkable state of preservation. Many of them have been in use for 1,500 to 2,000 years. The wooden pipe linings are made of *sunt* wood (*Acacia nulatica*) and the pipes are about 14 inches in diameter and surrounded with packed clay. It has frequently been found on examination that these casings are in as good a condition as when they were first put in, which demonstrates that under favourable conditions wooden pipes can be extremely durable.

In the year A.D. 1619, a water company in London laid many miles of wooden water pipes made from bored logs. The first water-supply to New York city and several other cities in the United States of America, were furnished through bored wooden pipes. The first wooden pipes supplying water to New Westminster near Vancouver, B.C., were found to be in an excellent state of preservation after 30 years of service. Bored logs had, however, limitations as to size of bore and consequent carrying capacity, and had to be abandoned later on as cities developed. The wooden pipe of to-day is made up of separate staves machined all over to conform to a perfect circular form and held together by a binding of steel wire in the case of small pipes and by steel clamps in the case of larger sizes. Such wooden pipes can be constructed to any requirements of size.

Wood does not seem to have found very much favour in India for this purpose. In the Moghul period, Agra and Delhi forts received their water-supply through pipes made of bored stone blocks. During the time of the Peshwas, Poona city was served with a water-supply obtained from a distance of about six miles through earthenware pipes. Copper pipes were used for fountains. But the writer has so far not come across any place in India where water is obtained through wooden service mains. He has, however, erected a number of teak vats in a big distillery for boiling *mohwa* (*Bassia latifolia*) flowers. These vats are giving excellent service although

the work is intermittent and the temperature variation is very great.

Some uses of wood pipe.—The following are some of the many diverse uses to which wooden piping is put in Canada:

Municipal water systems.
Private domestic water-supply.
Hydro-electric plants.
Mining developments for carrying away slimes, tailings, etc
Chemical plants for carrying acid liquids, etc.
Sewage disposal and outfalls
Irrigation systems.
Steam pipe insulation.
Air pipes for tunnel borings.
Flumes and wind tunnels.

Wooden tanks of every size and style up to 3,00,000 gallons capacity are in use for domestic and municipal water storage, for lumber and paper mill industries, for acid storage, for breweries and for canning plants. They are also used for hot water tanks in special industries, and for oil storage and many other purposes.

The manufacture of wood pipes.—Modern wood piping is built up of a number of wood staves machined on all four sides so as to produce a perfect circle of the required pipe diameter. After the staves are assembled, the pipe is tightly bound with galvanised wire spaced to suit the pressure for which it is intended. The wood

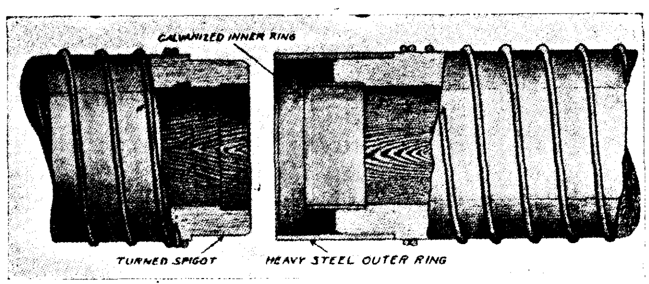


Fig. I.
TWIN STEEL RING JOINT,

for the staves is very carefully selected and seasoned and should be free from defects. After being bound with the wire, the ends are turned on a lathe to fit the couplings which are then pressed in. The pipe is finally bound with asphalt-saturated canvas and rolled in fine sand to facilitate handling and to assist in consolidating the asphalt on the pipe.

Advantages of wood piping.—The following are some of the advantages peculiar to wood piping. It does not decay as it is continually preserved by water. It does not rust or corrode like iron. Its friction losses being less than that of metal piping, it has a greater carrying capacity. The interior of the pipe always remains clear and free after years of service. Its carrying capacity, therefore, remains constant while that of metal piping decreases with age due to choking and furring. Wood piping does not taint or affect liquids passing through it. Its light weight reduces cost of transportation. It is not affected by electrolysis. Wood pipe keeps water cooler in summer and warmer in winter due to the non-conductivity of wood. Finally the use of wood piping opens up a new field of timber utilisation in India.

Life of wood pipe.—Many people have the idea that wood is always associated with rot, decay, insect attack and fire hazard and many other disadvantages. The truth is that wood has suffered in common with the domestic cat and is blamed for many things for which it is not responsible. If the same care and thought is given to wood as is done to steel, it is for many purposes, more efficient. A wood pipe carrying water will in reality last very long, as water saturated wood cannot rot. On the other hand, if a wood pipe or tank is liable to be alternately wet and dry, there is some danger of rot and decay setting in. In such cases treated wood should be used, and flumes and irrigation lines should always be constructed of treated wood. Conduits constructed of creosoted wood are still in service in Philadelphia, 45 years or more after their installation.

If a very durable wood like teak is used for pipes and tanks no preservative treatment is necessary.

Cost of wood pipe.—As the adoption of any material depends eventually upon what it costs to the consumer, the cost of wood pipes must also be considered together with the advantages. In 1924, 500 feet of 30 inches diameter wood stave pipe was laid by the Public

Health Department, Lucknow. It was made of $1\frac{1}{2}$-inches staves kiln-seasoned to 8 per cent. moisture content and machined all over so as to conform to the exact periphery of a 30-inch circle. This pipe was supplied at Rs. 6 per running foot without the iron band. Taking another rupee per foot for the band, the total price comes to about Rs. 7 per running foot. A steel pipe of the same dimensions would have cost at least $2\frac{1}{2}$ times as much. As wood pipe construction is not in vogue in India the above price does not represent the real cost. On a large scale the cost of wood pipes will be still less. With this low cost, in addition to the advantages mentioned above, the wood pipe can effectively compete with steel pipe construction.

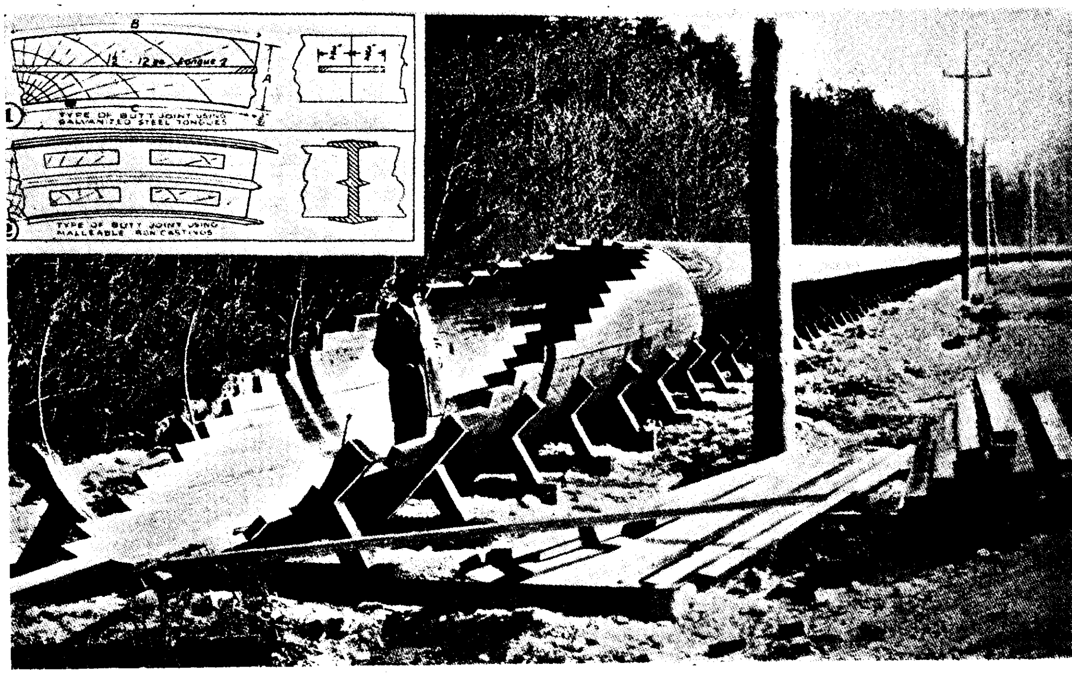
Couplings and fittings.—Three styles of couplings are in use. The inserted joint style coupling is made within the pipe itself. A bell or recess about 3 inches long is turned in one end of the pipe and a spigot to fit the bell is turned at the other end. The spigot of one pipe is inserted and driven into the bell of the adjacent pipe. This type of joint, although easy and cheap to make, reduces the thickness of pipe walls to half the thickness of the staves, and on account of this it is used for low pressures only.

The wood sleeve coupling was very largely used until recently when it was superseded by the twin steel ring coupling. The wood sleeve couplings are made of staves wound with wire in a similar manner as for the pipe, the wire spacing, however, being twice as close. The sleeves are 6 to 8 inches long and are turned internally so as to fit tightly over the ends of pipes to be joined.

The latest and most modern type of coupling is the twin steel ring style as shown in Figure 1. The pipe ends are turned both internally and externally to receive steel rings. The inner ring is 2 inches wide and is galvanized to prevent rusting. The outer ring is 3 to 5 inches wide and is made of much heavier steel. Both the rings are fitted on one end of each pipe. The specially turned other end of the next pipe is driven home between these rings to a snug tight fit. With saturation the wood end swells against the steel rings forming a perfectly leak-proof joint.

Cast-iron fittings such as elbows, tees, crosses, etc., and fittings such as gate valves, hydrants, air valves, cocks and other special fittings required in water works construction are also designed for use with wood pipes. Flanged and screwed connections can also be made.

CONTINUOUS WOOD PIPE



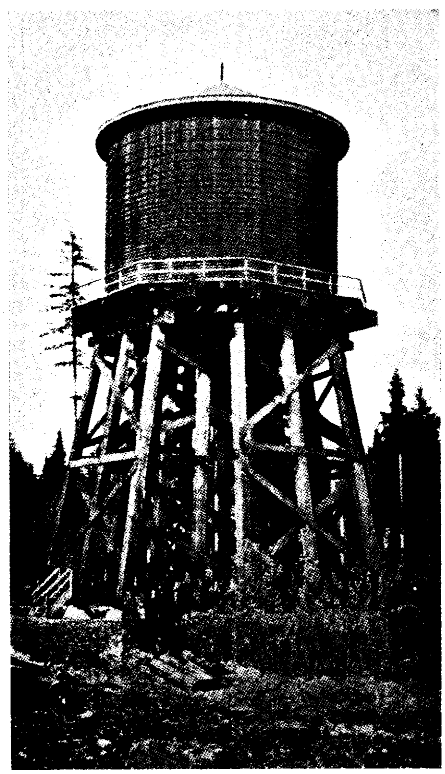
A CREOSOTED CONTINUOUS-STAVE WOOD PIPE BEING ERECTED WITH MALLEABLE BUTT JOINT.

Above a diameter of 20 or 24 inches, it is usually more convenient to build a wood stave pipe on site in one continuous length. Staves vary from $1\frac{5}{8}$ to $3\frac{5}{8}$ inches in thickness according to the size of the pipe and the pressure to be used. The staves are used in random lengths and the joints are broken by as much as two feet or more when building the pipe. The ends of the staves are slotted to receive tongues of steel to make a watertight joint. In more modern construction the steel tongue is avoided by cutting tongues on the end of staves so as to give a purely wood to wood contact doing away in this way with the rusting of metal tongues. The staves are held together by individual steel bands made of round mild steel varying in diameter from $\frac{1}{2}$ to $1\frac{1}{8}$ inch according to size of the pipe and pressure of water to be used in it.

A very distinct advantage of continuous wood stave piping is its adaptability to the contours of the ground in rough country. Great saving can be made in grading as the result of this feature

because the pipe can be built to adapt itself to the lay of the ground much better than any other pipe.

Wooden tanks.—Wooden vats have been in use for a long time for special purposes in different industries for the storage of chemicals, oils, hot water, etc., but their use for water-supply is a modern innovation. Overhead tanks supported on framed structures or masonry are often in demand, especially on railways and for the water-supply of small settlements. Wooden tanks are particularly suitable in such cases. Their advantage lies in the ease of transportation and erection, freedom from rust and contamination of the water, and insulation against heat and cold. When used for the storage of drinking water, wooden tanks keep it cool and fresh even in hot weather. In addition to these advantages the use of wooden tanks opens up a new field for the utilization of indigenous timbers.



A "CANADIAN" 130,000-GALLON DOMESTIC WATER SUPPLY TANK ON 40-FT. TOWER.

Suitable Indian timbers.—The choice of any particular wood will vary somewhat with the kind of service required. For temporary construction any cheap wood will do. Even *semul* (*Bombax malabaricum*) has been used. But for permanent good work a better type of wood must be chosen.

The following Indian species are suggested for the manufacture of pipes and tanks:

Tectona grandis	...	*teak.*
Lagerstroemia flos-reginae	...	*jarul.*
Lagerstroemia lanceolata	...	*benteak, nana.*
Lagerstroemia parviflora	...	*lendi, nandi.*
Lagerstroemia tomentosa	...	*leza.*
Phoebe spp.	...	*bonsum.*
Machilus macrantha	...	*machilus.*
Grewia tiliaefolia	...	*dhaman.*
Dysoxylum malabaricum	...	*white cedar.*
Carapa moluccensis	...	*pussur, kyana* (Burma).

FIELD WORK COURSE OF ENGINEERING FOR FOREST RANGER STUDENTS

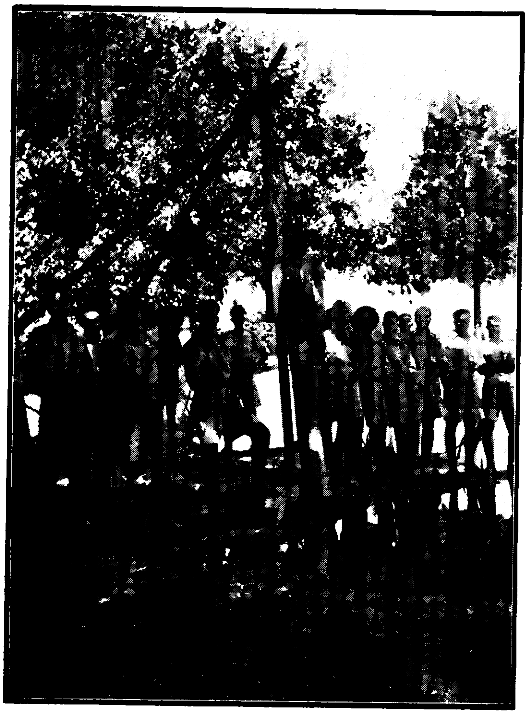
By W. T. Hall, I.F.S.

Director, Forest College, Dehra Dun.

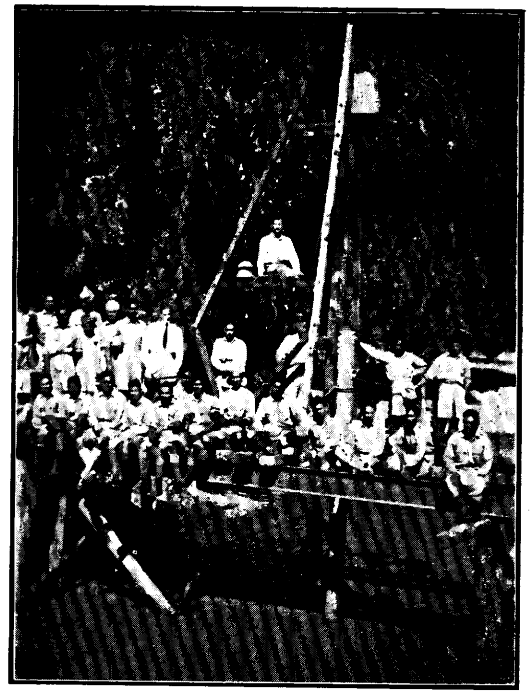
Summary.—The Ranger students of the Forest College do a field work course of engineering under the Bengal Sappers and Miners at Roorkee. This is a short account of the work done there.

In my address at the close of the 1935—37 Rangers' Course (*vide Indian Forester* for June 1937) I tried to give a general idea of the training of our Forest Rangers at the Forest College, Dehra Dun. In that address I could give little more than a passing reference to the practical field course of engineering under the Bengal Sappers and Miners at Roorkee. It may be of interest to the Provinces and States who send their students to Dehra Dun to have more detailed information regarding it.

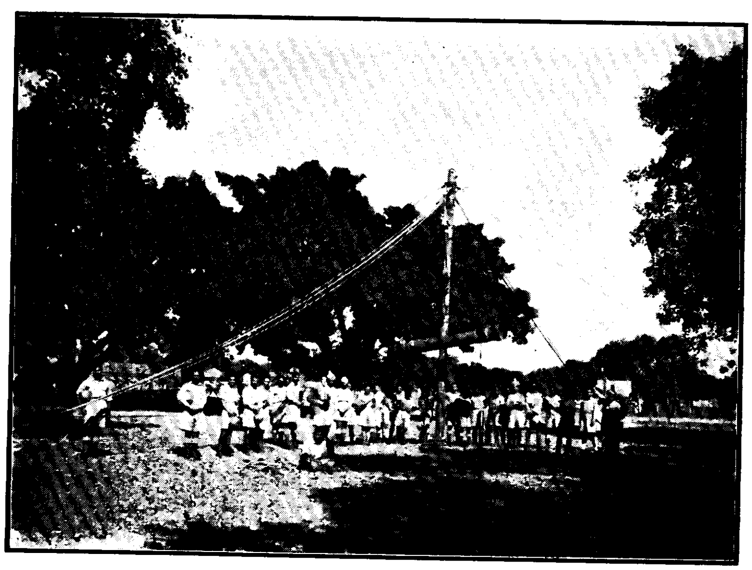
Roorkee is only 42 miles by road from Dehra Dun and is the Headquarters of the Bengal Sappers and Miners. They train their own recruits there and run courses of instruction for other branches of the army so there are excellent facilities for practical training in certain branches of forest engineering. Apart from a small



Trestle Pile-Driver
Photo : Ranger Student S. Qureshi



Portable Frame Pile-Driver
Photo : U. S. Madan



Standing Derrick
Photo : Ranger Student S. S. Pandit

honorarium to the Havildar instructors we pay nothing for the course or for the use of materials.

The course lasts for a period of about three weeks including holidays. I would like to emphasise that our students do everything themselves. You do not find the Havildar instructors doing a difficult job and saying, "That's how it is done," and leaving it at that. Nor do the students get recruits or coolies to handle materials from stores. There is sometimes a tendency amongst range officers to think it is *infra dig.* to do any kind of manual labour. This course should help to knock ideas of that sort out of their heads and I will say that our students have shown great keenness and have not learnt any old soldier's trick of dodging blistered hands and dirty clothes.

Regarding the actual programme of instruction, there is bound to be some difference of opinion. I have altered it twice myself but I am not at all sure that we yet have the most useful programme of instruction. In the time at our disposal it is not much use attempting some difficult work of building construction which will take a long time. It must also be remembered that certain kinds of forest engineering work can be studied during actual construction whilst we are on tour in divisions. Advantage of such opportunities is always taken whatever the main object of a tour. Specialised branches of forest engineering, such as aerial ropeways, are studied on tour in Kulu and forest tramways at Lalkua in the United Provinces and at Changa Manga in the Punjab.

The following notes are restricted to the main works undertaken during the course at Roorkee:

Knots and lashings, blocks and tackles.—I think most officers will agree that such a course should begin with instruction in the use of blocks and tackles. They are repeatedly used during subsequent construction. The students also learn various kinds of lashings and the correct common knots in ropes for various purposes (thumb knot, figure of 8, reef, single and double sheet bend, hauser bend, running knot, bowline and the common hitches). For convenience in instruction both fibre and wire ropes are sometimes used to lash timber members in subsequent work when we might more usually use bolts and dogs. A chain grip used for this purpose is particularly strong and easy to fix, and would occasionally be very useful in the forest.

Bridges.—Nine days are spent on the construction of three bridges, a trestle, a cantilever and a suspension bridge. Although ropes were sometimes used instead of nails and iron fastenings and decking planks were not nailed down to road-bearers, these bridges were not flimsy structures and were fully capable of taking the load for which they were designed. The students had at least to show their confidence in their own work by standing together in a party of 40 men on each bridge after completion. With perhaps less confidence I drove my car over the trestle and cantilever bridges.

Why we put a trestle bridge on the programme is fairly obvious, for I suppose that some kind of crib or trestle pier bridge is the most common type of multiple bay bridge used in the forests of India. With more time I would have liked the students to construct a crib pier. The best kind of crib pier I know for temporary forest bridges is that described by Brahmawar in the *Indian Forester* for October 1937. We had a lecture on this bridge from Mr. Brahmawar himself and a demonstration from a model. About a dozen temporary trestle bridges are being thrown across the Ganges at Hardwar for the Kumbh Mela and I hope to show the students these bridges under construction.

Why we have instruction from the Sappers on suspension and cantilever types is perhaps not so obvious. They are both common types of bridges in the hills of North-West India and about half the students of the 1937-39 Rangers' class come from hill provinces and states. Further, their construction presents special difficulties to the students and on account of their hidden anchorages these cannot be adequately explained from examples seen on tour.

Pile driving.—Three different kinds of pile driver which can be easily erected in the forest were constructed and used.

(1) *Portable frame pile driver.*—This consists of a wooden frame supporting two vertical timber leads. At the top of the leads is a pulley over which the rope passes for raising the monkey. The monkey used was of iron, but could be of any strong heavy wood. The monkey slides between the leads with an iron plate at the back. The monkey is raised by a rope worked by a hand winch. The monkey is released by a trip hook which fits into an eye at the top of the monkey which then falls free on to the head of the pile.

Suspension Bridge under construction

Photo : U. S. Madan

Suspension Bridge completed

Photo : Ranger Student S. S. Pandit

(2) *Trestle pile driver.*—This is a much simpler type designed for driving smaller piles. The vertical leads consisted of two iron rails but sawn timber could have been used instead. The leads rest on a wooden bed and are supported by a trestle tripod of *ballis.* In this case the monkey used was of wood.

(3) *Bangalore pile driver.*—This is another simple easily improved type in which the monkey works on a vertical iron rod, the lower end of which fits into the head of the pile.

Standing derrick.—The students put up a 20 feet derrick, the spar consisting of a chir *balli* held in position by four guys to wooden picket hold-fasts. The block of the lifting tackle was lashed to the spar suspended by a sling passing between two iron spikes driven into the head of the spar. The derrick was raised with the help of a moving lever about half the length of the derrick. The weight actually lifted was an iron drain pipe filled with concrete weighing 20 cwt.

Explosives.—Forest officers in the plains probably have little use for explosives but they are constantly used in hill divisions for road construction and would probably be used even more than they are if Range officers had more confidence in using them. Each student had to insert a length of fuse into a detonator and explode it. Earth-work was blown up by gunpowder. A tree was blown up with dynamite inserted in holes bored in the trunk. Another was blown over by a ring of primers. Concrete was blown up with dynamite. Forest officers never use guncotton but to amuse the students a cable was shattered by two slabs of guncotton fired by means of a dynamo exploder.

Masonry work.—The Sappers have an instructive series of full-sized models in brick to illustrate different kinds of bond and the arrangement of bricks in different thickness of wall; also models in stone to demonstrate the construction of a wall in ashlar, random rubble, coursed rubble, etc. Also an even more instructive series of full-sized models of various kinds of arches and fire-places. I find that in building instruction the construction of arches causes difficulty to students so they were divided into parties and built several types of arch using different kinds of centring. One of the most common faults in our forest buildings is a smoking chimney. The "Devon"

type or some modification of it with the back of the fire-place sloping forward and with a long narrow throat in the flue, is probably the commonest type now adopted in modern buildings and each party of students constructed one of this type in brick and mud.

Thomason College.—This famous Engineering College is in Roorkee and a morning is spent in the museums and workshops. We were also indebted to the Principal for placing one of the College tennis-courts and cricket nets at our disposal for practice.

THE INTERNATIONAL GAME EXHIBITION IN BERLIN

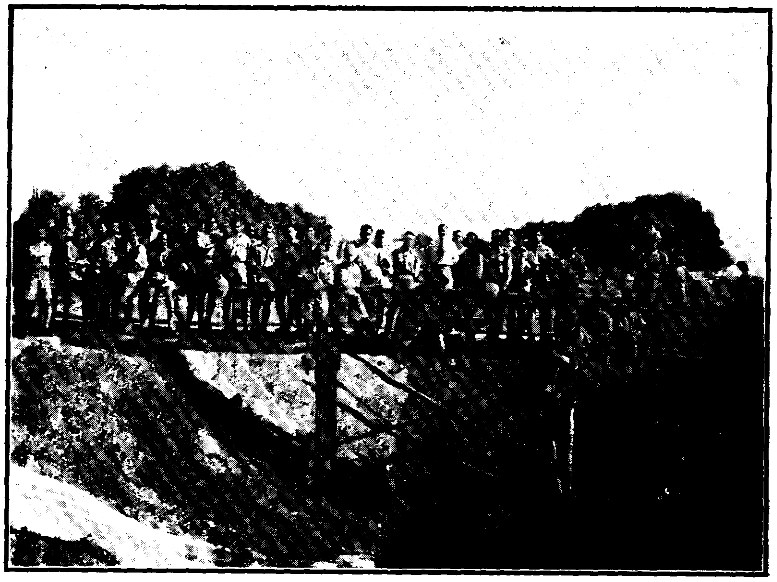
BY THE HON'BLE JAMES W. BEST, O.B.E. (I.F.S. RETIRED)

Indian foresters will be interested perhaps to hear of that part of the Berlin Exhibition which is of special interest to them as foresters.

India was well represented but mainly by Himalayan specimens of goats, sheep, etc. Our jungle heads made rather a poor show when they might have done so much better. But, it must be remembered that Mr. Eric Parker's committee had only five months in which to collect specimens, and realised that private collections from which specimens were drawn are scattered all over the world. As it was, Mr. Frank Wallace of the Shikar Club did wonderful work collecting and hanging all the trophies. In the British section there were no skins, so our friend the tiger had to take refuge in private collection in order to be seen by the Berlin crowds. When one remembers what a grand head the Indian sambur in his prime has it seems a pity that there were not more specimens. There were four, including a massive freak which scored a silver medal. There were two chital, two swamp deer, three nilgai, three sambur from Siam and the East Indian islands, three buffalo, two tsine and two gaur.

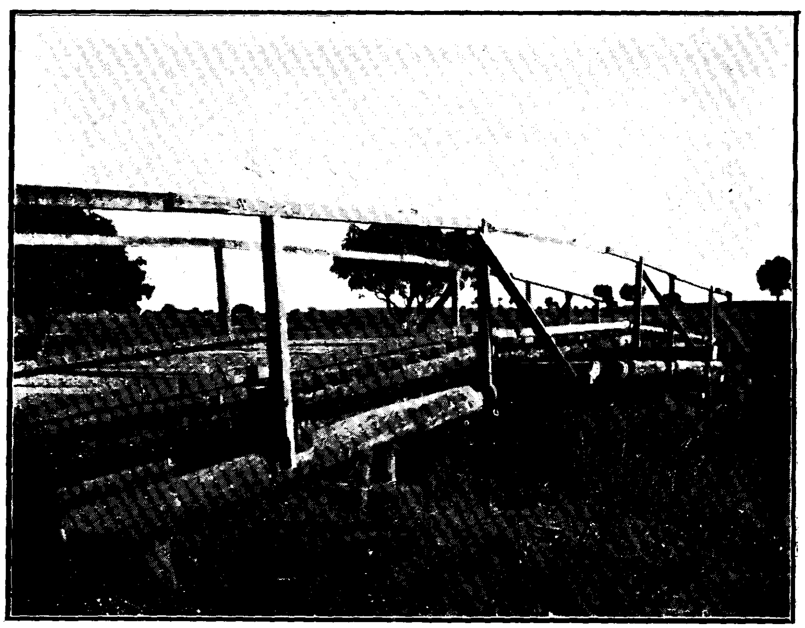
It is very much to be hoped that if, as is anticipated, the British section is shown in London before final dispersal our Indian forests will be better represented.

Apart from the British display at the International Game Exhibition in Berlin the falcons and the paintings have the greatest attraction for Englishmen. The former are no stuffed museum



Trestle Bridge

Photo : U. S. Madan



Cantilever Bridge

Photo : Ranger Student S. Qureshi

pieces but live falcons and hawks including eagles, goshawks, Iceland falcons, peregrines, and merlins, each tethered to its perch fixed over green grass lawns in the middle of three large halls. Some are hooded, but most of them sit contentedly on their perches, or, measuring the length of their leashes, take their midday meal. Now and again one will add a note of music as shaking her head she rings her bell. (There are highly technical terms for the various adjuncts to falconry which none but an expert would dare to use.) It is a most delightful scene for bird lovers. In the middle the falcons in a setting of green grass, and round the walls pictures and old volumes of this most romantic side of *venerie*. The British exhibit in this section is small but very well arranged and lighted.

Pictures of forest and hunting scenes occupy a large amount of space and are very well worth a visit. It is impossible to give a fair list of those meriting special attention, but probably the painting of an Indian bison or *gaur* by Ferdinand Schebek will attract the greatest attention from Englishmen with experience of the Indian jungles—it is a very remarkable picture. As one comes back to the British section one cannot help being struck by the fine arrangement of British sporting pictures by well-known artists which are grouped round an excellent portrait of H. M. The King. Messrs. Arthur Ackermann of Bond Street have loaned a collection of sporting pictures which has won generous approval from our German hosts. It includes two of shooting scenes by Stubbs.

Much attention has been given to the series of photographic enlargements of British field sports well captioned in three languages. It is in the photography of wild animals in their natural surroundings that British sportsmen have excelled. There was a time when those in search of big game took pleasure in being photographed in a striking attitude over the corpse of their unlucky victim. The new art is of a gentler sort and our countrymen have been rewarded with half of the total awards for this form of exhibit. It is interesting to note that the British photograph, awarded the gold medal, exhibited by Major Radclyffe Dugmore, showing a lioness on her kill, was taken so long ago as 1908 before the technique of this form of art had developed to its present standard. Niall Rankin's "Gannet in Flight" and Arthur Brook's "Golden Eagle" show beautiful action in clear outline. The other gold medal in this section went to

Germany. Fritz Krauskopf shows a German elk in delightfully wild surroundings.

But to return to the British section of trophies which is admitted to be one of the best parts of the exhibition. A massive buffalo head from the collection of the late J. Hall dominates the African section. Captain Brockelhurst's and Mr. R. Acroyd's elands are massive but cannot compare with the beauty of curve seen in Norman R. Smith's giant sable. That strange beast, the addax, is well represented by specimens from the collections of Mr. R. Colville and Mr. R. Acroyd. How such an animal can reach its size of horn and body in a sandy waterless desert of scant unappetising scrub is one of the mysteries of nature. Col. Price Wood's Tian Shan wapiti rivals its Canadian brothers in size and beats them in the spread from the cup. There is an ibex shown by Major Rooke which on account of its very great thickness of beam has been given a special gold medal although in the view of some visitors Lt.-Col. Gurdon's head showed greater beauty of horn. The sheep section is particularly good. A gold medal adorns H. M. The King's massive *ovis poli* as well as that of the late Marquis of Lansdowne. But for real beauty of curve the urial head cannot be beaten. Canadian moose and wapiti are well represented, particularly the former, of which there are eight heads, four receiving awards.

Every one of the 375 big game trophies in the British section is an outstanding specimen of its kind, or it would not be in Berlin. Before long they return to dignified retirement in English homes.—*(Copyright reserved.)*

REVIEWS

THE RATIONALIZATION AND CONSERVATION OF THE TIMBER RESOURCES OF THE WORLD

BY A. HAROLD UNWIN

(Published by the Technical Press, Ltd., Ludgate Hill, London, E. C. 4.)

This little booklet pleads for the more rational care of trees and woodlands, with special reference to Great Britain, and for a better and organized utilisation of the world's timber resources.

Several ways of achieving the desired goal are suggested, including the training of unemployed in woodcraft and woodworking, the linking of forest and allied departments, the foundation of timber institutes, museums, display halls, and libraries, and finally by collecting data and statistics and keeping these in the limelight by bringing them continuously to the notice of everyone.

The last chapter contains a list of what the author describes as "either the most important or most striking" timbers of the various countries of the world. The Indian list is as follows: "Deodar, True Cedar, Laurel wood, Shisham, Bombay Blackwood, Neem or Margose, Toon, Indian Rosewood."

Apart from Bombay blackwood being the same as Indian rosewood, and true cedar (which is *Cedrus libani*) not being indigenous, and in fact extremely rare in India, the list is not very representative. Neem is hardly one of India's "most important or most striking" timbers, while such well-known woods as teak, sal and chir pine are not even mentioned.

Nepal is given fir as its sole representative, followed by a large question mark. Indo-China and Cochin China are given "ingyin" as their one representative wood, also with a question mark. "Ingyin" is the Burmese name for *Pentacme suavis*. Apart from this rather astonishing list, the booklet is interesting, as it contains some original and sensible views as to how trees and woodlands can be used to better advantage and how timber utilisation can be improved.

HOLZ—ALS ROH-UND WERKSTOFF

(*Wood as raw and working material.*)

(*Volume* 1, *No.* 1/2, *October-November* 1937.)

In Europe, as well as in America, there is no dearth of trade journals dealing with the commercial and practical aspect of wood and wood-working, yet the results of scientific interest relating to various technical properties and uses of wood are found scattered in a variety of journals—forestry, engineering, chemistry, physics, biology, etc., on account of the lack of a journal devoted solely to wood, its chemical, physical, mechanical and technical properties. Germany has taken the lead by bringing out such a journal, edited by Prof. Dr. Ing. F. Kollmann, of the Prussian Wood Research Institute, Eberswalde, in collaboration with a galaxy of eminent scientists drawn from most of the European countries, each one distinguished in his own branch of science. The journal will appear monthly, published by Messrs. Julius Springer of Berlin.

A perusal of the first issue indicates two main features of the journal, namely reports of original scientific work and exhaustive abstracts of current literature relating to the entire field of properties and uses of wood, besides small news items and book reviews. The first number contains a number of original scientific papers by well-known workers on a variety of subjects, such as, "Wood as raw material in the world economy," "Timber growth analysis and its evaluation in wood research," "Properties and uses of synthetic resin glues," "The present position of wood saccharification," etc. The abstracting of literature is done on a comprehensive scale, and it is gratifying to note that Dr. D. Narayanmurti of this Institute has been taken as a collaborator in this work.

The journal should prove very helpful to those engaged in any branch of research relating to wood as raw or finished material, and I wish it every success.

S. N. K.

REPORT ON THE ADMINISTRATION OF THE FOREST DEPARTMENT, COCHIN STATE, FOR 1935-36

The administration of the Forest Department in Cochin followed customary lines during 1935-36 and no appreciable changes in area or methods of working occurred. To the existing area of 4,057 acres of teak plantations, 270 acres stocked with teak stumps by the *taungya* method were added. We are glad to find that the detailed working plans are now in course of preparation.

The outturn of timber (teak, rosewood, *Xylia xylocarpa, Lagerstroemia, Terminalia paniculata, Terminalia tomentosa* and *Bombax malabaricum*) was, on the whole, somewhat less than during the preceding year, but the financial results showed an unexpectedly high surplus of Rs. 1,16,105 owing to a slight rise in the price of plantation teak, and principally to the heavy speculative prices paid for rosewood suitable for export to Europe.

The forest tramway worked satisfactorily and profitably.

Elephant-capturing operations were not undertaken during the year.

C. R. R.

EXTRACTS

TIMBER

The Board of Trade returns show that during the nine months ending September 1937, imports to the United Kingdom of timber classed as unmanufactured from all sources of supply were valued at £43,160,300 as against a value of £30,109,935 for the corresponding period of 1936. Of these imports hardwoods, hewn and sawn, totalled 750,000 tons valued at £6,872,297 as against 625,500 tons valued at £5,378,729 in 1936.

Imports of plywood during the same period were 12,010,500 cubic feet valued at £3,660,881 in 1937 and 10,496,000 cubic feet valued at £3,039,792 in 1936.

The returns do not yet differentiate imports from Burma. Imports of sawn teak, mainly from Burma, were 36,220 tons valued at £794,645 during the first nine months of 1937, as against 34,640

tons valued at £669,880 during the same period in 1936. Figures of the imports of other timbers from India and Burma are not available.

Deliveries of timber through the medium of this office totalled 525 tons during the quarter. There have been a number of enquiries for gurjun. Otherwise there has been little enquiry for Indian timbers during the quarter.—(*Report of the Indian Trade Commissioner, London, for the quarter ending September* 1937.)

READY-MADE HOUSES

Advocacy of the pre-fabricated timber house as an aid to the solution of the rural housing problem was a feature of an address which Mr. E. H. B. Boulton, Technical Director of the Timber Development Association, gave on Tuesday at the Housing Centre, London.

Mr. Boulton referred to the just-issued report of the Rural Housing Sub-Committee of the Central Housing Advisory Committee, and suggested that a lesson might be learned from the garden cities of Stockholm, which had a population of 50,000, with an annual increase of about 2,500. The plan for assisting the poorer classes of the community to obtain their own homes is officially known as the Small Cottage Scheme, Mr. Boulton said, and is intended for people who are unable to contribute any capital towards acquiring a ready-built cottage. The citizen does the personal labour in the erection of the houses. The City Corporation have constructed proper streets with sewers, gas and water mains and electric light in these new areas, and thus avoided the nature of "shanty towns," with the sanitary drawbacks usually attached to such communities.

The principal system is to have all wall sections and other parts of the houses, such as finished cills, floor joists, beams, floor and ceiling boards, manufactured at a factory ready for use. The advantages of such a system are that the cost of transport is reduced and the house more quickly roofed and at once protected from the weather.

The use of standardised sections has the additional advantage that only the minimum of skilled labour is required. The ready-cut sections can be almost entirely put together by the future owner of the house himself, even though he is unfamiliar with such work.

"Such a scheme carried out in this country would go far to relieve the great shortage of houses for the agricultural worker," said Mr. Boulton. "The pre-fabricated houses would require fresh planning for the conditions in this country where the climate is not so severe. No cellar would be required, and the walls would not need to be of such solid, thick pieces of wood, and, therefore, in spite of the cost of freight and extra transport, such cottages would give instant relief, for they are fit for occupation immediately the roof is on, and they would also be cheap both in upkeep and heating costs.

"Vertical weatherboards do not fit in with the English countryside, and we are more accustomed to horizontal weatherboards. Much depends, however, on the type of timber used and the methods of finishing the building.

"The cry 'Back to the Land' would be encouraged if there were living accommodation planned as small community dwellings, so that each village again had its social life of a dart board and a pub. Isolated houses, whatever the building material, do not encourage the younger generation to marry and settle down in the country, and properly planned village suburbs should be built on lines similar to the garden suburbs of Stockholm."—(*Timber Trades Journal, 30th October* 1937.)

HEATHER BEETLE

There has occurred during the last few years an alarming increase in the damage to grouse moors from the ravages of the heather beetle, and in places this damage has been so great as to denude large areas of heather, with consequent migration of grouse and great loss to the owners. The British Field Sports Society, of which the President is the Duke of Beaufort, has therefore decided, after a careful survey of the problem, to conduct a scientific inquiry, with a view to discovering a practical remedy for this pest.

The work is already in progress, and is being carried out under the supervision of Dr. A. E. Cameron, head of the Department of Agricultural and Forest Zoology of Edinburgh University, with whom will be associated his assistant, Mr. J. W. M'Hardy, Lecturer in Entomology of the same University, and Dr. G. Morison, Advisory

Officer in Entomology, of the North of Scotland College of Agriculture, Aberdeen. In addition, the services of a whole-time investigator have been engaged. Dr. Cameron and Dr. Morison have already carried out considerable research work in connection with the heather beetle.

A Serious Menace

A pamphlet issued by the British Field Sports Society in connection with the investigation states that the heather beetle (*Lochmaea suturalis*) has been known for many years, and has for some time past been the cause of serious damage to grouse moors in the South-West of Scotland. In the last few years infectations of the beetle have also occurred in other parts of the country, and it represents to-day one of the most serious menaces to grouse preservation and moorland sheep-farming. It has been recorded as far north as Sutherland and Caithness, and again in the North of England and in Wales, and even as far south as Exmoor.

Its density varies upon different moors, some being seriously affected, while others in the immediate vicinity may be only slightly damaged, although the quality of the heather and other conditions appear to be identical.

The presence of the heather beetle on a moor should be easily recognisable. During July and August, while the beetle is in the grub or larva stage, the green shoots of the heather begin to wither, and in a very short time they turn a rusty red over the whole of the infested area. The boundaries of a patch of beetle-eaten heather have been known to spread at the alarming rate of 15 yards a day. The heather so attacked is useless for food, both for grouse and sheep. Grouse leave the affected area, and the heather, if any remaining, is seriously impaired.

Attempts to Find Remedies

Many practical attempts to find a remedy have been made by proprietors, their gamekeepers, and sheep farmers. So far, however, none of these have proved successful. Burning has been suggested as a cure; but this can be effective only during July and August, after which date the beetle hibernates beneath the surface, and the fire passes over it without doing it any harm. But muir-burn in July and August is illegal in Scotland, and in any case the season renders it impracticable, since at this time of year the sap is up, and in order

to burn the heather properly in summer and early autumn the heather must be exceptionally dry, with the consequent danger of burning the peat beneath.

Spraying with an insecticide has also been suggested, but, even if effective, the expense which is necessarily involved in spraying a large area of rough and often mountainous moorland would seem to rule out this method.

It has thus become evident that the cure, if cure there be, is beyond the range of the proprietor or his gamekeeper, and the problem must be approached scientifically by the expert.

Scope of the Inquiry

A detailed programme of the proposed investigation can be obtained, post free, from the British Field Sports Society. The plans have been so drawn up as to cover every aspect of the problem, and to embrace the consideration of every possible remedy. The general course of the life history and development of the beetle through egg, larvæ, pupa, and adult stages is being studied, and special attention will be paid to the density of population of the beetle under dry and wet moor conditions, at different elevations and under conditions of hill-set and flat moorland, with a view to finding some practical method of control.

For this purpose particular study will be made of (1) parasites and predators; (2) the effect of heather burning at different times of the year; (3) the effect of drainage; and (4) insecticides, which, it is thought, may prove a cheap and practical method of control in cases where the beetle first appears only in small patches. In addition to these four possible methods, others which it may be necessary to follow up may come to light in the course of the inquiry.

Heavy Initial Expenses

An investigation of this character must necessarily occupy two or three years as a minimum. Special scientific apparatus must be acquired, an annual payment must be made to a whole-time investigator, and means of transport and travelling expenses provided to enable him to visit outlying parts of the country. In addition, there will inevitably be unforeseen contingencies to be met. The British Field Sports Society is satisfied that if the investigation is successful, its economic advantages to grouse-moor owners and sheep farmers

will be incalculable. The initial expenses, however, must necessarily be heavy. The Society, convinced that the problem is one which brooks no delay, has therefore itself undertaken to finance the inquiry.

An appeal for financial help to enable the British Field Sports Society to meet the additional call on its resources entailed by this inquiry has been issued by the Duke of Beaufort, President of the Society, Lord Middleton, Chairman, and Mr. Eric Parker, Chairman of the Shooting Committee.—(*Statesman.*)

FORESTRY IN THE HIMALAYAS

A warning about the "grave danger that lies in the ill-planned deforestation of the Himalayas," which he said he had noticed in the Nanga Parbat areas, was expressed by Professor C. Troll, one of the two survivors of the German Nanga Parbat expedition.

He urged Indians to take up the study of forest economy. "The problem is serious," he said, "and unless it is tackled early, grave consequences are likely to follow."

Turning to other aspects of his expedition, he said that Nanga Parbat, which was little known before the German expedition, has provided much valuable information. Being drier than the Sikkim Himalayas, the southern face is without vegetation. But its northern side is thickly covered with plants, and these plants belong not to the families which were found in the southern part of either the Kumayun, the Nepal or the Sikkim Himalayas, but more to the families of plants to be found in Central Asia or Afghanistan.

Prof. Troll's tour in the Sikkim Himalayas was undertaken particularly to observe the type of flora in this part, which is very moist most of the year. In spite of the weather being wet, he said, he had been able to collect splendid specimens of moss, seeds and plants.

The German expedition to reach the summit of Nanga Parbat, led by Dr. Karl Wien, Professor of Geography in the Munich University, met with disaster in June, when an avalanche

overwhelmed their camp. Of the nine members of the expedition all lost their lives except Dr. Ulrich Luft, of Munich, and Professor Troll, who were not in the camp at the time.—(*Statesman.*)

STEREOSCOPIC MAPPING WITH MULTIPLEX PROJECTOR

A 25-square mile tract can be "picked up" from an airplane and set down on a table top in three dimensions by means of an instrument known as a multiplex projector now being built by Bausch & Lomb Optical Co., for the U. S. Army Air Corps.

"The device makes the user feel precisely as though he were a superbeing standing over the earth and able to caress the tops of mountains and run his hand along the bottoms of great gorges. So perfect is the reproduction that a giant smoke stack looks realistic enough to prick a finger even at 25,000 times reduction.

"The method involves no actual model making with tools. A complete representation of a countryside can be obtained in a field station within a few hours after the exploring plane takes off.

"Hitherto made only abroad, this costly precision device is now being built in the laboratories of Bausch & Lomb to meet War Department requirements and for general map-making purposes. Aside from its value in preparing for military operations in unfamiliar terrain, it is said to be the most convenient and rapid means for accurate map-making available.

"By simple measurement with a scale in the reduced model one can measure the height of a hummock or the slope of a road as easily as one can measure the height of an inkstand on a desk.

"A plane working in conjunction with the aero-projector begins operations over an area containing three points accurately surveyed by traditional methods. As it flies out into unmapped territory, the shutter of an automatic camera looking down clicks at regular intervals.

"The film is then developed and printed on small glass plates which are used as lantern slides in a battery of projectors mounted above a table. The images formed by adjacent projectors on the table overlap just as do the areas covered in successive photographs. Alternate projectors form their images in red and green light. The user wearing spectacles with one lens red and the other green, sees the

overlapped area stereoscopically. He gets the same impression of depth as though he were a giant so huge that his eyes were set apart by the distance the plane flew between successive pictures.

"The scene does not look natural, however, until the orientations and positions of the battery of projectors reproduce exactly the relative orientations and positions of the taking camera.

"A number of operators can work simultaneously drawing relief maps under one battery of projectors. The whole system of images appears a meaningless jumble of red and green light and shadow to a person not wearing the colour spectacles."—(*Current Science, August* 1937.)

WORK OF BRITAIN'S LARGEST FOREST NURSERY

In the heart of the Denny Hills work has recently begun on an ambitious scheme which in the course of a few years will make of what is now mostly bare hillside an outstanding beauty spot.

This transformation is being wrought by the work of the Forestry Commission, who have in recent years entered upon a vigorous campaign to restore Britain's forestlands—long denuded by neglect and the exigencies of industry and war. In an area of over 6,000 acres of hill country acquired from the Stirlingshire and Falkirk Water-Board, squads of workmen are busy preparing the ground and constructing fences and ditches for this latest afforestation scheme, where planting will begin early in the year.

It is on a sheltered hill-slope of West Fife, overlooking the long, gleaming span bridging the Forth at Kincardine, that most of the trees for these new forests have their birth. There, on a wide tract of Tulliallan Estate, is situated the largest Forestry Commission nursery in the British Isles, with a constant stock of no less than 40,000,000 trees, from which is supplied every State forest in Scotland and many in England and Wales.

Cones Gathered by Tinkers

Every tree at Tulliallan is raised from seed, and, to keep the stock of trees at a sufficiently high level to meet the ever-increasing demand, seeds are extracted from cones sent to the nursery from all parts of the world. A few years ago most of these cones came from European and Scandinavian countries, but, since larch and Scots pine have

increased in the Forestry Commission's own plantations, most cones of these trees are gathered in Scotland. Norway spruce cones are imported in large quantities from that country, as are Sitka spruce from British Columbia, and Japanese larch cones from Japan.

In Scotland, as in other parts of the world, the cones are gathered during the autumn by wandering tinkers, who make this one of their regular seasonal activities, and each year about 2,000 bushels of cones come in sacks to Tulliallan. Until about the middle of last century foresters in this country were greatly hampered by the widespread practice of using fir cones as winter fuel in every home, and seed had to be imported ready for planting, as seed-extracting methods had not then been perfected in Britain.

Scented Drying-Sheds

Nowhere in the nursery is the scent of the pinewoods so powerful as in the sheds where the cones are dried and the seed shaken from their heart to be collected in large trays for washing and packing. From the sacks in which they arrive, the cones, so tightly compressed as to look like medium-sized nuts, are emptied on to tiers of wire racks, where they gradually dry in the warm air which circulates freely round them. With upwards of a hundred thousand cones on each rack, it is not surprising that the air of this shed has a pungent quality.

From these racks the cones are taken for further drying to a great kiln where they pass down through a series of trays, getting steadily hotter and gradually opening until they are emptied into a large, revolving hopper at a still higher temperature, from which the seed falls down chutes to be collected at the foot of the kiln.

Careful watch is kept over the temperature of the various sections of this kiln, for all the seed is not affected in the same manner by the heat, that of larch, spruce, and Scots pine being extracted from the kiln at different temperatures.

Converted Laundry Boiler

Most difficult seed of all to extract is that of the larch, for so hard are its cones that they must be partially ground before being placed in the kiln; and even when the seed is extracted it must be further crushed and washed to remove all trace of the hard shell of chaff which encloses each grain. In sharp contrast is the seed of the Scots pine, black on one side and brown on the other, which is shaken

from the cones clean and glistening and ready for packing immediately.

The great drying kiln at Tulliallan Nursery is the only one of its kind in Britain, and is a worthy example of the foresters' ingenuity; for, without plant of any similar sort in existence to act as a guide in its construction, it was made from an old laundry boiler. Its fire, incidentally, provides a convenient and economic means of disposing of the cones after they have been emptied of their seed.

The old method of extracting seed from the cones by the use of a hand-drum is still employed at Tulliallan, but this is a slow and laborious business, and is used only when a small quantity of seed is required for some special purpose.

PROTECTIVE MEASURES

It is in February that the nursery presents its busiest aspect, for in that month the seeds extracted from the cones during the autumn and winter are sown in parts of the 120 acres not already occupied with yearling trees, or due to lie fallow for the season. So sheltered is the nursery by the near-by Ochil Hills that, on a recent evening when most of Fife and the Lothians glistened with frost, only three degrees of frost were registered in the open there. Even a mild frost, however, may be fatal to the tender seedlings of less than a year's growth, and these tiny shoots, showing barely half an inch above the earth, are covered practically all the year round with a protective wooden framework. At the end of two seasons the trees are "lined out" in long rows at intervals of six inches, ready for removal to the forests.

Of all the trees in the nursery, the feathery larch is most rapid in its growth, and at two years old it is a delicate miniature of its future self, over a foot in height and with trunk and leaves alike of a beautiful golden brown. But, even at the end of two years, the Scots pine and the various members of the spruce family are still hugging the ground in thick clumps of dark green, with but little indication of their mature grandeur.

GIANTS FROM CANADA

Although the larch is among the most numerous of the trees now reared by the Forestry Commission, it is not a native of Britain, having been introduced just over a century ago from Central Europe;

and the Forestry Commission are continuing pioneer work of this sort by the introduction of many varieties not indigenous to these islands. None of these will make a more spectacular change to our land than the Sitka spruce from British Columbia, which is being grown very successfully in the West Highlands of Scotland; for though its tiny, black seed—smallest seed of any conifer—is only the size of a pin's head, it grows in 60 years to a veritable giant of the forest, towering 120 feet in the air and with a trunk that two men with outstretched arms cannot span at its base.

The Japanese larch is another recent newcomer to our forests, and at present much of the experimental work at Tulliallan is concerned with the production of a hybrid tree from this species and the familiar Scots pine.

St. Kildans Among Workers

Whilst in the planting season as many as 90 workers may be employed at Tulliallan, the permanent employees there number only 15, and among them is Donald Fergusson, formerly postmaster on the lonely island of St. Kilda, who, with the entire population of that island, itself treeless, was on its evacuation in 1930 "adopted" by the Forestry Commission to engage in afforestation work on the mainland. Among the five members of Donald's household is his father-in-law, Findlay MacQueen, now 75 years old. He was the oldest of St. Kilda's inhabitants at its evacuation, and enjoyed the affectionate title of "King of St. Kilda," which he still holds among his new neighbours. The old man has a cheery greeting for every visitor to Tulliallan, but few understand its wording, for it is in his native Gaelic, still the only tongue he knows. The whirr of the spinning-wheel, in their family for generations, is still an everyday sound in the home of this little band of exiled islanders; but no longer is their yarn woven into sturdy homespun—socks and jumpers are all they produce now.

Not only to the people of St. Kilda, however, has the work of the Forestry Commission come as a welcome means of livelihood; for hundreds of crofters in the West and Central Highlands it has meant a continuance of life among their native hills and glens when it seemed that increasing centralisation of markets must sweep their tiny crofts from existence.—(*Evening News, 8th January* 1938.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for January 1938:

IMPORTS

ARTICLES	MONTH OF JANUARY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
Siam ..	..	40	189	..	3,466	24,761
Burma ..	..	..	13,405	..	..	17,64,841
French Indo-China	..	..	100	..	..	13,761
Other countries ..	5	352	784	456	35,524	1,03,091
Total ..	5	392	14,478	456	38,990	19,06,454
Other than Teak—						
Softwoods ..	1,205	404	1,893	65,686	24,862	1,44,837
Matchwoods ..	..	1,563	1,002	..	90,547	57,722
Unspecified (value)	..	..	..	2,30,624	42,940	3,86,611
Firewood ..	37	31	76	555	465	1,140
Sandalwood ..	3	12	..	1,298	8,738	247
Total value ..	..	..	..	2,98,163	1,67,552	5,90,557
Total value of Wood and Timber ..	..	..	..	2,98,619	2,06,542	24,97,011
Manufactures of Wood and Timber—						
Furniture and cabinetware ..		No data			No data	
Sleepers of wood ..	..	..	21	..	..	1,336
Plywood ..	..	385	646	..	90,119	1,47,709
Other manufactures of Wood (value) ..	..	..	..	2,86,680	1,41,596	2,43,379
Total value of Manufactures of Wood and Timber other than Futniture and Cabinetware ..	..	..	..	2,86,680	2,31,715	3,92,424
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	25,976	33,164	9,102	1,71,423	2,14,522	76,325

EXPORTS

ARTICLES	MONTH OF JANUARY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	4,273	3,904	..	8,18,154	8,30,405	..
,, Germany ..	150	748	..	31,833	1,50,797	..
,, Iraq ..	28	18	13	4,341	2,136	880
,, Ceylon ..	145	87	3	14,605	10,107	120
,, Union of South Africa ..	199	449	..	35,121	80,508	..
,, Portuguese East Africa ..	402	184	..	63,019	31,942	..
,, United States of America ..	74	55	..	17,810	16,559	..
,, Other countries	293	253	115	59,255	53,932	29,509
Total ..	5,564	5,698	131	10,44,138	11,76,386	30,509
Teak keys (tons) ..	347	485	..	50,400	66,970	..
Hardwoods other than teak ..	103	110	..	10,827	11,048	..
Unspecified (value)	..	..	..	26,356	93,844	70,855
Firewood ..	28	6	51	400	80	700
Total value ..	..	..	..	87,983	1,71,942	71,555
Sandalwood—						
To United Kingdom	10	..	3	12,060	..	3,350
,, Japan ..	9	5	11	9,638	5,000	13,070
,, United States of America ..	79	..	103	84,800	..	1,11,775
,, Other countries	6	14	27	9,622	15,265	27,192
Total ..	104	19	144	1,16,120	20,265	1,55,387
Total value of Wood and Timber ..	..	..	..	12,48,241	13,68,593	2,57,451
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	11,656	12,035	28,093
Other Products of Wood and Timber		No data			No data	

INDIAN FORESTER

MAY, 1938.

PYINKADO YIELD TABLES—A FIRST APPROXIMATION

BY B. E. SMYTHIES, B.F.S.

Summary.—Data were collected by measuring a number of temporary sample plots in the *pyinkado* plantations of Tharrawaddy division (dating from 1918), and by studying the available permanent sample plot records. Use is made of O'Connor's parabolic relation for free-growing trees as an aid to finding the number of trees per acre at different ages.

The tables worked out are not empirical, giving average figures like Bourne's yield tables for teak, but theoretical, giving ideal or "normal" figures, which can be attained by adopting a suitable thinning regime; few of the plantations sampled actually attain these figures, because in most cases past thinnings have been inadequate; the permanent sample plots, which have been the most carefully thinned, come nearest to them.

The object of management being taken as the production of 3′ poles (as many and as quickly as possible), thinning heavily enough to produce the maximum diameter increment is sound in theory but may have to be modified in practice owing to the excessive branchiness of *pyinkado* under too open conditions; thus, though intended as a guide to thinnings, the tables must be used with caution, especially when opening out previously under-thinned crops.

1. In Tharrawaddy Division there are many acres of *pyinkado* (*Xylia dolabriformis*, Benth.) plantations, and, as little is known about normal heights, diameters, and stockings per acre for this species, it was decided to attempt the compilation of a rough local yield table. The procedure described in "The Methods of Preparing Volume and Money Yield Tables for Teak Woods . . ." by R. Bourne was closely followed, and use was made of a paper on "Forest Research with Special Reference to Planting Distances and Thinning" by A. J. O'Connor, to which reference is invited. While on recess in Maymyo, the writer had access to the Permanent Sample Plot Records, and expanded the original scope of this paper to include the figures given in these Records.

2. In the Tharrawaddy Yoma plantations, 45 quarter-acre plots were laid out in pairs in each locality; one plot to sample the area showing the best height growth, and the second plot to sample the area showing the poorest height growth; plots were only chosen in places where the stocking was full. All except two of these plots were last thinned in 1933-34 or 1934-35. All years from 1918—1927 were sampled (except 1920 in which no *pyinkado* was planted pure).

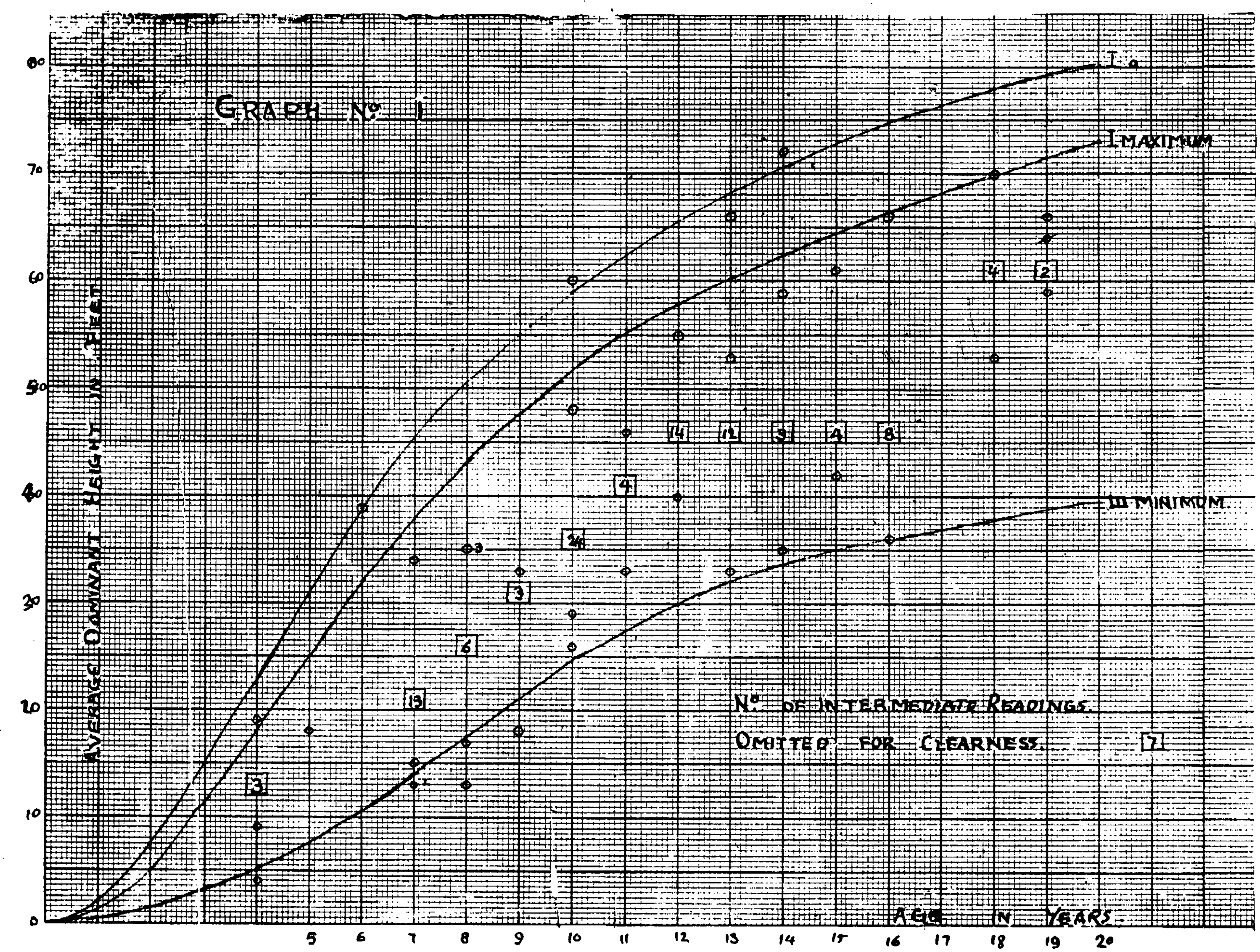
3. In the Plains Reserves two one-acre plots, four half-acre plots, and 49 plots 40′ × 40′ (approximately 1/27th of an acre) were

A

measured in 1918—1927 year plantations, and a further 40 plots 40′ × 40′ were measured in 4—9-year-old plantations. It was decided that a 40′ × 40′ plot was too small a sample to give reliable figures for diameter or basal area, so that only the height figures from these plots were utilised. The figures for the one-acre, half-acre, and quarter-acre plots are given in the Appendix.

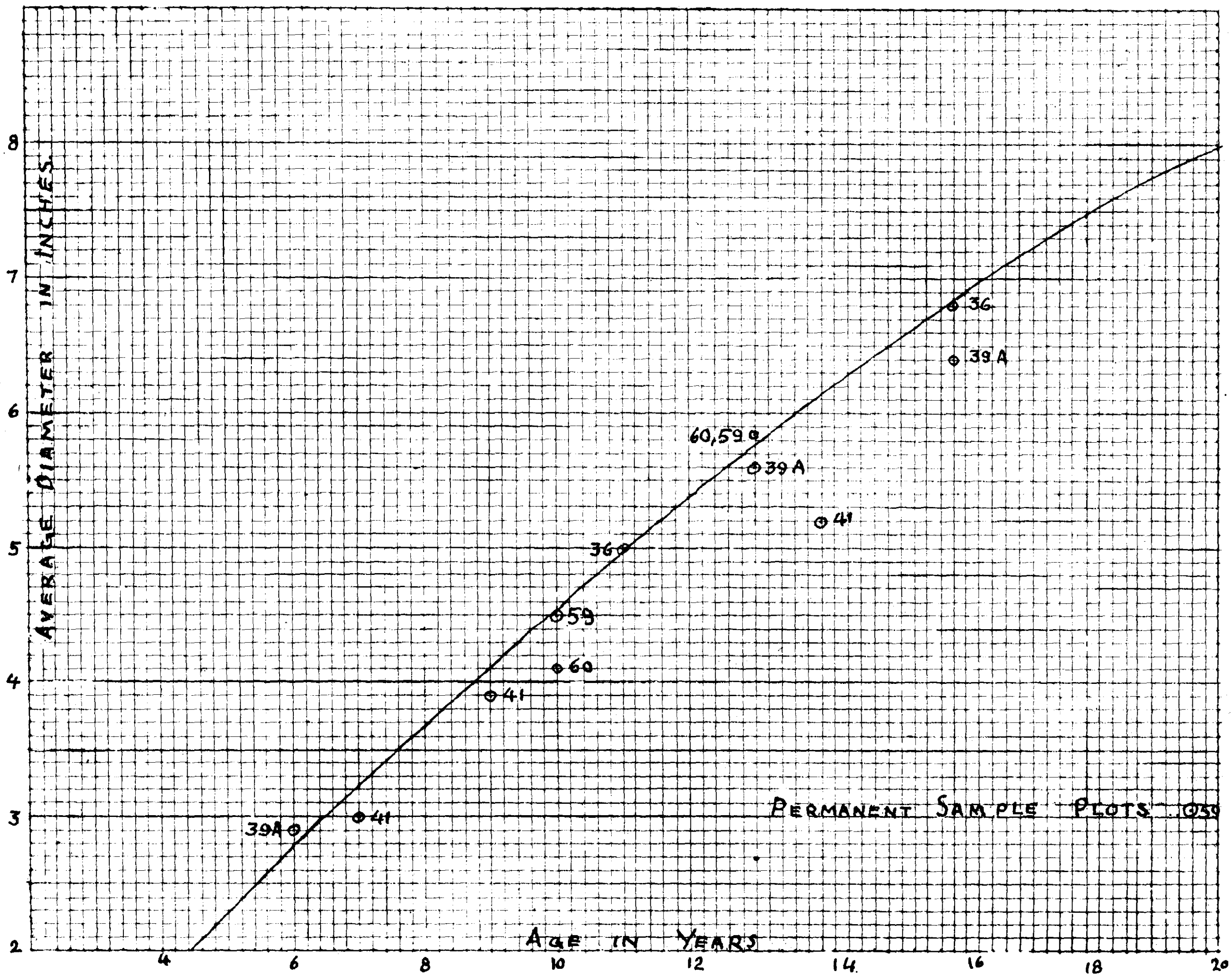
4. In all these plots the height and girth of every tree were measured. In the quarter-acre plots the average height of the 15 tallest trees and in the 40′ × 40′ plots of the two, three, or four tallest trees was calculated. The results were plotted graphically, average dominant height (top height) against age, and two curves were drawn to pass through the highest and lowest sets of points (see Graph No. 1). A rough height increment curve can be prepared from the top height figures of those permanent sample plots that have been measured more than once. The curve for quality I maximum was then adjusted slightly to conform with the height increment curve. As there are unfortunately no permanent sample plots in quality III, the curve for quality III minimum cannot be checked in the same way. The space between the two curves was then divided by trisecting the ordinates, and the Table of Normal Height Growth for Dominant Trees for three classes was then prepared from the graphs (Table 1). The one-acre, half-acre, and quarter-acre plots were then allotted to quality classes by means of Table 1. It was found that the height figures for permanent sample plots Nos. 23, 24, 25, and 18, and for one temporary sample plot in the Thindawyo Reserve, Tharrawaddy Division, were well above the quality I maximum curve, so a curve to represent quality I*a* was drawn through these upper points.

5. The next step was to try and draw graphs of normal average diameter against age for each quality class. As a first step it was decided to draw curves to represent maximum diameter increment or something near it, *i.e.*, the diameter increment that would be shown by free-growing trees. The average diameter of each sample plot was adjusted by raising or lowering it by 0.1″ for each foot that the top height of the sample plot was above or below the average top height of the quality class to which the sample plot belonged. These adjusted values were then plotted against age, *vide* Graph 3, and it will be seen that the dispersion of the points in each



GRAPH No. 1
I
I MAXIMUM
III MINIMUM
AVERAGE DOMINANT HEIGHT IN FEET
AGE IN YEARS
No. OF INTERMEDIATE READINGS
OMITTED FOR CLEARNESS

GRAPH No. 2



AVERAGE DIAMETER IN INCHES.
AGE IN YEARS
PERMANENT SAMPLE PLOTS ⊙59
2
3
4
5
6
7
8
4
6
8
10
12
14
16
18
20
39A
41
41
60
59
36
60,59
39A
41
36
39A

quality class is very great; this can only be due to big differences in treatment, *i.e.*, in degree of thinning. From the point of view of attaining the maximum diameter increment (whether we should aim at this or not is discussed lower down) nearly all the sample plots are grossly under-thinned. Three curves were drawn through the maximum points in each quality class and mutually harmonised. A fourth curve was drawn through the three points available for quality I*a*. These four curves represent normal diameter increment for average quality I*a*, II, and III plantations.

6. Actual figures for diameter increment are available from some of the permanent sample plots. These are plotted in Graph 2, which gives a useful check on the curves in Graph 3. Comparing the quality I curve in Graph 3 with the curve in Graph 2 we see that the latter curve represents a rate of diameter increment slightly lower than that represented by the former; the curves conform very well in shape. Now Graph 2 represents, as far as we can tell at present, a diameter increment curve corresponding to a grade of thinning between B and C grade. The gradient of the increment shown by plot No. 60, which was thinned to C grade, is steeper than the gradient of Graph 2. Therefore by thinning to C grade, or possibly D grade, it should be possible to raise the diameter increment curve until it coincides with the quality I curve in Graph 3. In a plot thinned to D grade there should be very little suppression, *i.e.*, the trees are approximately free-growing.

7. The average diameter for each year for each quality was read off Graph 3 and entered in Table II.

8. The next and most difficult step was to compile a table of normal number of stems per acre for each quality class. O'Connor has shown in his paper that there is a strong probability that basal area values vary with the square of the growing space; *i.e.*, if the average basal area per tree is plotted against growing space the result is a parabola of the form $y=ax^2$. This only applies to trees that are free-grown, or nearly so.

9. *Pyinkado* is planted 1,210 trees to the acre, so that to find the relative growing space at any age this figure 1,210 is divided by the number of trees per acre at that age. In order to find the value of the constant "a" in the equation, the figures of those permanent sample plots that had been thinned to C grade were examined. For

instance plot No. 25 was thinned to 550 trees per acre when six years old; we may assume from this that if the area had been planted with about 600 trees to the acre, the effects of suppression would not have been noticeable by the end of the sixth year, *i.e.*, the trees would have shown the same diameter increment as free-growing trees. We calculate "a" thus:

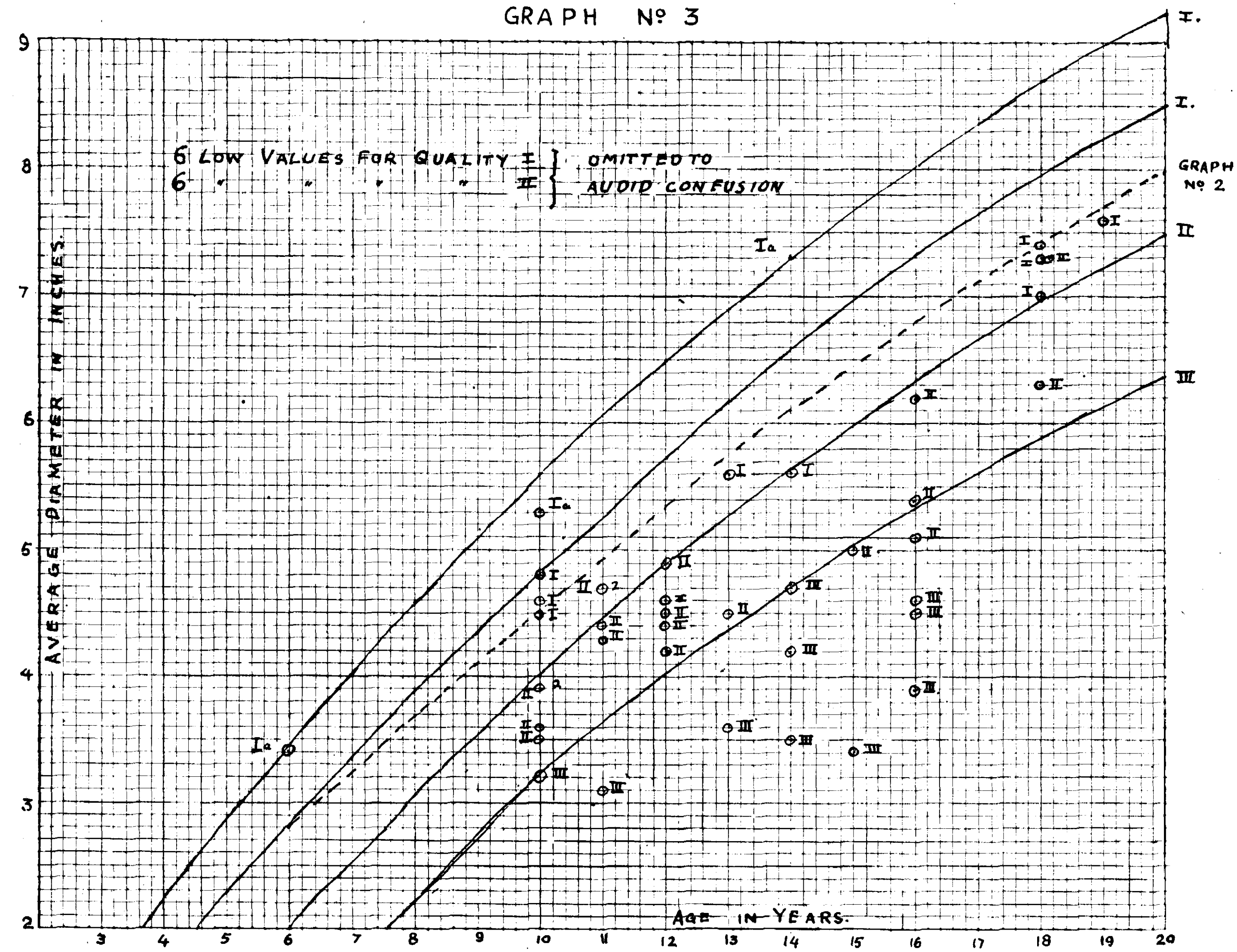
Age.	Average diameter in inches.	Average basal area in sq. ft. = y.	No. of stems per acre.	Growing space = x	x^2	$y/x^2 = a$
6	3·5	·0669	600	2·02	4·06	·0164

Similar calculations were made for other sample plots and the value a = 0.016 was finally adopted. The curve $y = 0.016\ x^2$ was then plotted (Graph 4); the stocking per acre for any given average diameter can be read off this curve. By taking only one curve for all three qualities we are assuming that suppression is independent of height, *i.e.*, we assume that in two plots of, say, 500 trees per acre of the same average diameter, in one of which the top height is 50′ and in the other 40′, the effects of suppression will be noticed in the same year in both plots. Only further research work can show how far this assumption is justified. When more data are available it may be found necessary to draw three parabolas corresponding to three different values of the constant "a," one for each quality class.

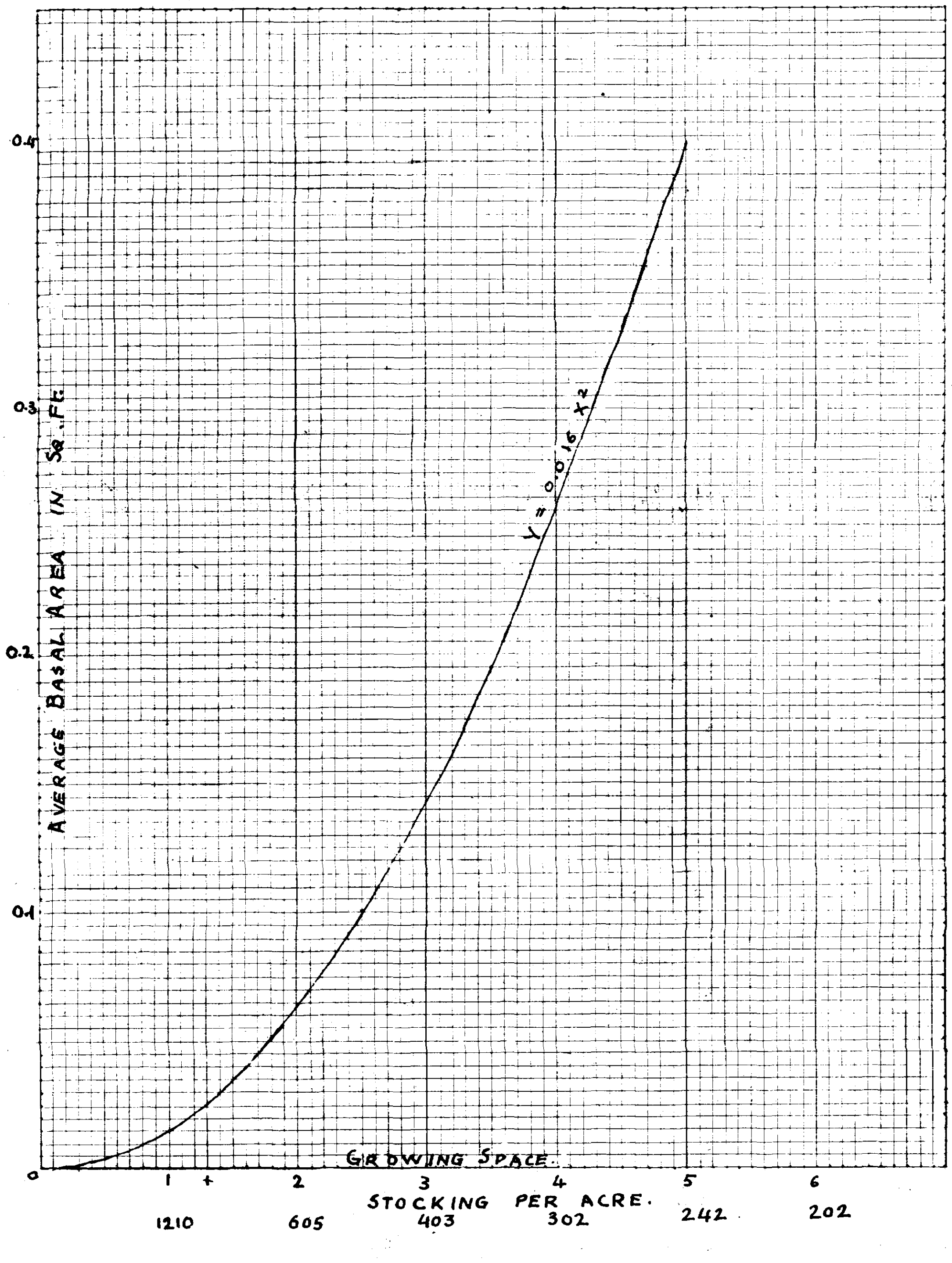
10. The figures for stocking per acre were entered in Table II and the basal area was calculated by multiplying the average basal area by the stocking per acre. The form factor for *pyinkado* appears to vary from about 0.44 to 0.52. Rough volume figures can be calculated by using an average form factor of 0.48.

11. We must now consider how far it is justifiable in practice to thin to such a degree that competition is eliminated, so that the trees put on the same increment as free-growing trees would do. In Tharrawaddy Division the annual domestic consumption of fuel was estimated at 250,000 cart loads. The Conservator of Forests, Working Plans Circle, considers that a large part of this is obtained from unclassed forests, drift, old house-posts, etc., and that the amount which will have to be supplied from reserved forests is much less

GRAPH No. 3


6 LOW VALUES FOR QUALITY I } OMITTED TO
6 " " " " II } AVOID CONFUSION
AVERAGE DIAMETER IN INCHES
AGE IN YEARS
GRAPH No. 2
I.
I.
II
III
Ia
9
8
7
6
5
4
3
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

GRAPH No. 4.



AVERAGE BASAL AREA IN SQ. FT.
0.4
0.3
0.2
0.1
0
Y = 0.016 X²
GROWING SPACE
1
2
3
4
5
6
STOCKING PER ACRE.
1210
605
403
302
242
202

than was previously estimated: he considers that it can all be supplied from green fuel coupes and intermediate yields from plantations. The final yield will therefore be devoted to the production of poles or posts of a size and on a rotation that will depend on the policy of Government, when enunciated, for these plantations.

The exploitable girth of *pyinkado* in Tharrawaddy is 3′; trees of this size sell for Rs. 3 each, whereas smaller trees fetch only Re. 1 each, or at the most Re. 1-8-0. From the financial point of view we must aim at growing the maximum number of 3′ girth trees per acre in the shortest possible time. If we thin to eliminate competition the second condition will be fulfilled, but it might pay better to thin rather less heavily in the hope that the greater number of trees in the final yield will more than compensate for the longer rotation that would be necessary; to decide this point further figures from sample plots on the effect of different grades of thinning on diameter increment must be awaited.

12. Ideally thinnings should be done every year; in practice they are only carried out every five years, which introduces complications. To take an example: Table II gives the normal number of stems per acre for quality I as 440 at 10 years and 300 at 15 years.

(*a*) If we want the maximum diameter increment we must thin down to 300 stems at 10 years, otherwise suppression will operate before the 15th year; but this means a waste of growing space in the years 10—14: in the year 11, for example, there will only be 300 trees per acre, whereas 390 could be growing without loss of diameter increment.

(*b*) Alternatively we can thin down to 440 stems per acre at 10 years and allow suppression to operate in the years 11—15. There will be loss of diameter increment, but there may not be loss of volume increment.

(*c*) Or we can compromise by thinning down to some figure between 440 and 300 stems per acre at 10 years.

It seems likely that (*a*), (*b*) and (*c*) correspond roughly to D, B and C grade thinning.

13. Mr. Blanford, in *Burma Forest Bulletin* No. 9, dated 1923, makes the following remarks on thinnings in teak plantations:

"It may also be admitted that once a teak plantation has been allowed to get congested, the annual increment per acre is not only

reduced, but it then takes a number of years after thinnings have been carried out to bring the current annual increment up to what it would have been if the stand had been correctly thinned. This necessitates a longer rotation to produce timber of any desired girth and even five years added to a rotation makes a considerable difference to the final yield. . . . With teak, however, it may be accepted that a thinning should be made sufficiently heavy to allow the canopy to close up only at the end of the period between thinning; or, in other words, that thinnings should be carried out as soon as the canopy has closed up."

14. It seems likely that these precepts apply equally well to *pyinkado*, and we should therefore adopt alternative (*a*) above; to be on the safe side, however, it would be better to adopt alternative (*c*), *i.e.*, to thin to C grade, or to a combination of (*a*) and (*c*), *i.e.*, to thin to D grade during the first 10 or 20 years and to C grade subsequently, with the object of obtaining the maximum average diameter in early life when the diameter increment rate is at its height and then easing off to increase the number of trees in the final yield. It may be found in practice, however, that a D grade thinning in early life will result in an excessive growth of side branches, in which case it would be better to thin to C grade throughout. If this is done the diameter increment will be less than that of free-growing trees, and the figures will fall below those given in Table II.

Very little data are at present available on the effect of different grades of thinning on diameter and volume increment, but the figures for the following two permanent sample plots are instructive:

Plot 39A.—Thinned in years 6 and 13 to "ordinary" (B grade ?)
Plot 39B.—A contiguous plot, left unthinned until the year 13, and then "lightly" thinned (A grade ?).

Plot.	Age.	Top Height.	Stems per acre after thinning.	Average Diameter.	Basal area of final yield.	Basal area of intermediate yield.	Basal area of total yield.
39A	6	27	571	2·9	27·0	22·1	..
,,	13	52	401	5·6	69·5	13·9	105·5
39B	6	27	1107	2·7	45·1	Nil	
,,	13	47	635	4·8	81·2	22·1	105·3

The effects of suppression are shown up well by these figures. The diameter increment is much poorer in plot 39B, and the height growth also appears to have been affected, probably owing to root competition. The two plots, on a 13-year rotation, produce very nearly the same total yield: plot 39A produces a smaller final volume yield, but owing to the greater average size of the trees the final money yield of the two plots would probably be much the same. On a longer rotation there is little doubt that plot 39A would be the more profitable, and we may conclude that, whether the object of management is the production of the maximum volume of fuel or of the maximum volume of posts of a specified diameter, plot 39A is in all cases the better of the two. It pays to thin, and that heavily

The subsequent history of these plots will be interesting.

14. *The time taken to reach an average diameter of 3′ was* worked out for each quality class by prolonging the curves in Graph 3: the figures apply to a D grade thinning.

A comparison of the figures for permanent sample plots 24 (thinned to B grade) and 25 (thinned to C grade) indicates that plot 24 may take ten years longer than plot 25 to reach an average diameter of 3′, and for a quality III plot the extra time taken would probably be about 20 years. The rotations needed work out as follows:

Quality.	D grade thinning.	B grade thinning.
Ia	30 years	40 years
I	35 ,,	45 ,,
II	42 ,,	57 ,,
III	50 ,,	70 ,,

The figures for B grade are, however, very speculative, being based on only one remeasurement, and must be taken with caution. The next remeasurement of plots 23, 24, and 25 will allow a more accurate estimate to be made.

15. How the figures in Table II can be used in practice as a guide to thinning still remains to be discussed. It is all very fine to lay down that a 10-year-old quality II plantation must be thinned to 330 trees to the acre—the subordinate who goes into a plantation does not know the quality or the initial stocking per acre, and in the hills areas of uniform quality are very limited in extent. A table of the average distance between trees after thinning for different ages suffers from the same drawbacks as a table of number of stems per acre.

A possible method is to lay out three demonstration plots, one for each quality, and, after thinning them to the prescribed figures, to have them inspected by all thinning officers: their subsequent work can be checked by measuring a few sample plots in areas thinned by them and seeing how far the figures diverge from the normal. The dispersion of the figures in Graph 3 indicates the extent to which the personal factor can affect thinnings, and it also demonstrates the great importance of careful and adequate thinning in the first 20 years of a plantation.

16. *Summary*—

(*i*) The production of trees 3′ in girth was taken as the primary object of management, and of house posts and fuel as secondary objects because it seems likely that the needs of the local population for these can be met from intermediate yields.

(*ii*) The figures of 10 permanent sample plots and of 51 temporary sample plots were analysed with the object of preparing a yield table.

(*iii*) The great importance of adequate thinning in early life, if retardation of the diameter increment rate and a consequent lengthening of the rotation is to be avoided, was clearly revealed by this analysis.

(*iv*) The yield table was therefore prepared for trees that approximate in their diameter increment to free-growing trees; it seems likely that the table will apply to a plantation thinned to D grade; the diameter increment of trees thinned to C grade does not lag far behind and in actual practice a C grade thinning may be preferable.

(*v*) Many of the plantations sampled show average diameters far below those given in the table, and it is probable that they have been seriously under-thinned.

Normal height growth of dominant pyinkado trees for classification of pyinkado plantations

Age.	Ia.	I.	II.	III.
5	32	19—25	14—18	8—13
6	38	25—32	18—24	11—17
7	44	30—38	22—29	14—21
8	50	35—43	26—34	18—25
9	54	39—47	30—38	22—29
10	58	43—51	34—42	25—33
11	62	46—55	37—45	28—36
12	65	49—58	39—48	30—38
13	68	52—61	42—51	32—41
14	71	54—63	44—53	33—43
15	73	56—65	46—55	35—45
16	75	58—67	47—57	36—46
17	76	59—69	48—58	37—47
18	77	60—70	49—59	38—48
19	79	61—72	50—60	39—49
20	80	62—73	50—61	39—49

TABLE NO. II.

YIELD TABLE FOR PYINKADO, D GRADE THINNING, FINAL YIELDS ONLY.

Age.	Quality I-A.				Quality I.				Quality II.				Quality III.			
	Average height in feet.	Average diameter in inches.	Stocking per acre.	Basal area per acre in square feet.	Average height in feet.	Average diameter in inches.	Stocking per acre.	Basal area per acre in square feet.	Average height in feet.	Average diameter in inches.	Stocking per acre.	Basal area per acre in square feet.	Average height in feet.	Average diameter in inches.	Stocking per acre.	Basal area per acre in square feet.
5 ..	29	2·9	710	31	19	2·2	940	25	13	1·4	1210	13	8	0·8	1210	4
6 ..	35	3·5	590	37	26	2·8	740	32	18	1·9	1090	21	11	1·3	1210	11
7 ..	41	4·0	520	43	31	3·3	630	37	23	2·4	880	25	15	1·8	1150	21
8 ..	47	4·6	450	50	36	3·8	540	43	27	3·0	690	32	19	2·3	900	24
9 ..	51	5·1	410	57	40	4·3	480	48	31	3·5	590	37	23	2·8	740	30
10 ..	55	5·6	370	63	44	4·8	430	54	35	4·0	520	44	26	3·2	650	34
11 ..	59	6·1	340	69	48	5·2	390	57	38	4·5	440	49	29	3·6	580	39
12 ..	62	6·5	320	74	51	5·7	360	64	41	4·9	410	54	31	4·0	520	43
13 ..	55	6·9	300	78	53	6·2	330	69	44	5·3	390	60	34	4·4	470	47
14 ..	68	7·3	280	81	56	6·6	310	74	46	5·7	370	66	35	4·7	440	50
15 ..	70	7·7	270	87	58	7·0	300	80	48	6·0	350	69	37	5·0	410	55
16 ..	72	8·0	250	87	60	7·3	280	81	49	6·3	330	71	38	5·3	390	58
17 ..	73	8·3	240	90	61	7·6	270	85	50	6·6	310	74	39	5·6	370	63
18 ..	74	8·6	240	97	62	7·9	260	89	51	6·9	300	78	40	5·9	350	66
19 ..	76	8·9	230	100	64	8·2	250	92	52	7·2	290	82	41	6·1	340	69
20 ..	77	9·1	230	104	65	8·5	240	95	53	7·5	280	86	41	6·4	320	71

Note.—Average height taken as top height *minus* 3 feet.

PERMANENT SAMPLE PLOTS

Sample Plot No.	Division.	Reserve.	Compartment No.	Age.	Trees per acre.	Top height.	Mean height.	Average diameter in inches.	Basal area per acre	Quality.
			QUALITY IA AND I.							
23	Myitkyina ..	Bilumyo ..	4	6	715	37	34	3·3	43·5	Ia
24	" ..	" ..	4	6	660	37	34	3·5	43·4	Ia
25	" ..	" ..	4	6	550	38	34	3·4	35·0	Ia
39A	Tharrawaddy	Sitkwin ..	30	6	571	27	25	2·9	27·0	I
41	" ..	Konbilin ..	37	7	547	33	31	3·0	27·1	I
11	Toungoo ..	Yetkanzin ..	22	8	544	41	39	3·9	45·3	I
41	Tharrawaddy	Konbilin ..	37	9	380	42	38	3·9	31·9	I
25	Myitkyina ..	Bilumyo ..	4	10	396	60	?	5·3	?	Ia
61	Tharrawaddy	Sitkwin ..	28	10	557	43	39	4·3	56·1	I
60	" ..	" ..	28	11	402	46	44	5·1	57·0	I
59	" ..	" ..	29	11	439	48	45	5·1	62·2	I
36	" ..	" ..	5	11	436	50	48	5·0	59·5	I
11	Toungoo ..	Yetkanzin ..	22	13	361	57	55	5·4	57·5	I
39A	Tharrawaddy	Sitkwin ..	30	13	401	52	50	5·6	68·6	I
60	" ..	" ..	28	13	402	..	..	5·8	..	I
59	" ..	" ..	29	13	439	..	..	5·8	..	I
18	Bhamo ..	Mosit ..	41	14	164	72	67	7·3	47·0	Ia
41	Tharrawaddy	Konbilin ..	37	14	291	56	51	5·2	42·9	I
36	" ..	Sitkwin ..	5	16	315	61	?	6·8	79·5	I
			QUALITY II.							
39B	Tharrawaddy	Sitkwin ..	30	6	1107	27	25	2·7	45·1	
39B	" ..	" ..	30	13	635	47	47	4·8	79·6	

TEMPORARY SAMPLE PLOTS, THARRAWADDY DIVISION.

Plot No.	Reserve.	Compartment No.	Year.	Age.	Trees per acre.	Top height in feet.	Average diameter in inches.	Basal area per acre in square feet.	Area of plot in acres.
			QUALITY I.						
1	Konbilin ..	9	1927	10	360	45	4·5	40	¼
2	Nyaungbinzin ..	41	,,	10	356	46	4·5	39	¼
3	Konbilin ..	21	,,	10	396	46	4·8	50	¼
4	Thonze ..	68	,,	10	1000	48	3·5	67	¼
5	Mokka ..	25	1925	12	844	55	4·1	77	¼
6	Sitkwin ..	29	1924	13	438	52	5·4	70	½
7	Konbilin ..	9	1923	14	300	59	5·7	53	¼
8	Minhla ..	13	1922	15	364	61	5·4	58	¼
9	Konbilin ..	9	,,	15	460	56	5·1	65	¼
10	Minhla ..	9	1921	16	536	61	4·5	59	¼
11	,, ..	9	1919	18	188	70	7·6	59	¼
12	,, ..	9	,,	18	236	62	6·7	58	¼
13	Thonze ..	66	,,	18	300	62	6·4	67	¼
14	Sitkwin ..	5	1918	19	354	63	7·0	94	½
			QUALITY II.						
15	Konbilin ..	9	1927	10	376	41	3·8	30	¼
16	Nyaungbinzin ..	41	,,	10	328	37	3·8	26	¼
17	Konbilin ..	21	,,	10	348	37	3·8	27	¼
18	Mokka ..	34	,,	10	724	37	3·5	48	¼
19	Thonze ..	68	,,	10	896	38	3·2	50	¼
20	Minhla ..	9	1926	11	560	38	4·1	51	¼
21	Konbilin ..	21	,,	11	368	45	5·1	52	¼
22	,, ..	9	,,	11	356	39	4·1	33	¼
23	,, ..	9	,,	11	340	45	5·1	48	¼
24	Sitkwin ..	28	1925	12	494	48	5·1	70	½
25	Minhla ..	8	,,	12	564	47	4·5	62	¼
26	,, ..	8	,,	12	712	42	3·2	40	¼
27	Mokka ..	32	,,	12	640	40	4·5	71	¼
28	Nyaungbinzin ..	38	,,	12	324	48	4·8	41	¼
29	,, ..	38	,,	12	380	40	4·1	35	¼
30	Minhla ..	8	1924	13	628	50	3·5	42	¼
31	Thonze ..	66	,,	13	616	49	4·8	77	¼
32	Minhla ..	8	1923	14	664	46	3·8	52	¼
33	,, ..	13	1922	15	392	49	5·1	56	¼
34	Sitkwin ..	30	1921	16	306	53	6·4	68	1
35	,, ..	30	,,	16	461	54	5·4	73	1
36	Mokka ..	32	,,	16	520	53	5·1	74	¼
37	Thonze ..	51	,,	16	440	48	5·1	62	¼
38	Sitkwin ..	30	1919	18	198	58	7·6	62	½
39	Thonze ..	66	,,	18	252	53	6·1	51	¼
40	,, ..	66	1918	19	395	59	5·1	56	1/5

TEMPORARY SAMPLE PLOTS, THARRAWADDY DIVISION—concld.

Plot No.	Reserve.		Compartment No.	Year.	Age.	Trees per acre.	Top height in feet.	Average diameter in inches.	Basal area per acre in square feet.	Area of plot in acres.
				QUALITY III.						
41	Mokka	..	35	1927	10	876	26	2·9	40	¼
42	Minhla	..	9	1926	11	640	33	3·2	36	¼
43	,,	..	8	1924	13	732	39	2·9	34	¼
44	Thonze	..	66	,,	13	808	38	3·8	64	¼
45	Minhla	..	8	1923	14	716	35	3·2	40	¼
46	Konbilin	..	9	,,	14	376	41	4·5	42	¼
47	Thonze	..	51	,,	14	640	36	4·5	71	¼
48	Konbilin	..	9	1922	15	336	42	4·8	42	¼
49	Minhla	..	9	1921	16	496	36	3·5	33	¼
50	Mokka	..	32	,,	16	628	36	4·1	58	[illegible]
51	Thonze	..	51	,,	16	468	42	4·8	59	¼

REAFFORESTATION IN ITALY

By J. N. Sinha, Bihar Forest Service

Abstract.—Reafforestation of bare hills is being carried out in Italy on a large scale. The general method is called "Gradoni" or level terracing, which has been perfected after extensive experiments.

(By arrangement kindly made by the Director of the Imperial Forestry Institute, Oxford, with the Italian Forest authorities, the writer visited Italy in April and stayed for over a week. He was shown round the important afforestation works near Florence and on Mount Subasio in Central Italy. The following note is based on facts and figures largely collected on the spot.)

Nature of Reafforestation.—Reafforestation of bare arid mountains is being carried out in Italy on a scale perhaps unapproached in any other country in the world. In 1933, one of the peak years, 10,732 hectares (1 hectare = $2\frac{1}{2}$ acres) or 42 square miles were afforested by the Forest Department. Assisted afforestation by private land-owners is also done to an appreciable extent. It is not a case of filling in blanks or improvement of the growing stock through gradual replacement by more valuable species. It is one of restoring to

productivity naked mountain sides, thousands of square miles in extent, that were denuded of vegetation centuries ago and have since been subject to erosion, impoverishment of soil, desiccation, and perpetual grazing of what little might tend to grow. They bear a striking resemblance to the mountain of the Khyber Pass.

Objects.—The main objects of reafforestation are:

(1) To check large-scale erosion on mountain slopes. The soil is derived from argillaceous limestone and shale and particularly liable to "sheet" erosion. Silting up of fertile orchards and fields has been a serious problem in Italy.

(2) To control the disastrous floods caused by periodical heavy downpours.

(3) To increase the supply of timber and firewood. At present Italy imports large quantities of timber.

The "Gradoni" system.—The method of afforestation that has been evolved comparatively recently after years of work and experience is called the "Gradoni" system (from the Italian word "gradoni" which means terrace). It consists in contour-terracing the slopes as intensively as may be necessary to catch and retain the greater proportion of the rainfall and prevent loss of soil by run-off; the intensity clearly depends upon the steepness of slope, the degree of aridity and other features of the soil. Plants are put out in the terraces. The obvious preliminary to any attempt to grow vegetation on these dry steep mountain slopes is some measure, such as the "gradoni," for conserving moisture in the sub-soil.

The general procedure is to lay out first of all what are called "principal gradonis." These are best spaced from 6 to 10 metres (20 to 30 feet) apart measured along the slope but in rocky areas the intervals are of necessity irregular. They run continuously round the contour except where impediments, such as big rocks, occur to interrupt them.

In between the principal "gradonis" are made secondary "gradonis" called "piazzuole." These are generally 3 metres (or 10 feet) apart. Whenever the area is not very rocky "piazzuole" run continuously and parallel to the "gradoni" and are somewhat narrower than the latter; commonly, however, "piazzuole" turn out to be discontinuous "gradoni" in stretches as long as it is possible to make them.

REAFFORESTATION IN ITALY.

Fig. 1.—A near view of "gradoni." On the flatter ground "buche" or pits in between the "gradoni" and "piazzuole" on the slope. "Piazzuole" are not necessary on flat ground.

Fig 3.—Close up of a part of a "gradoni" showing the size and inward slope. The plants are surrounded with stones to reduce drying up of the soil around them.

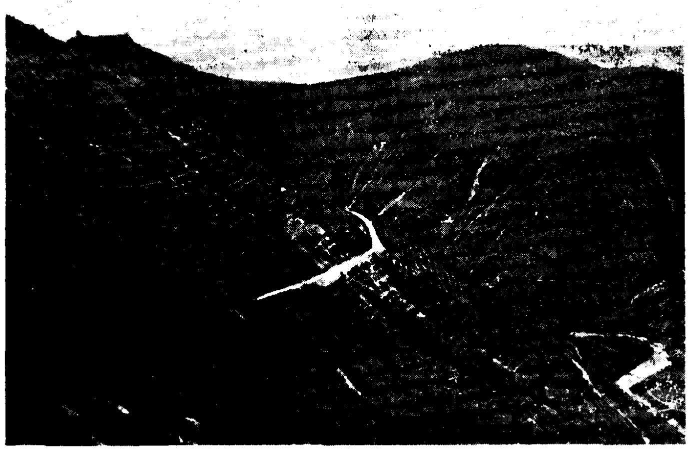


Fig. 2.—A view of "gradoni." On the right is a stony arid hill not yet taken up.

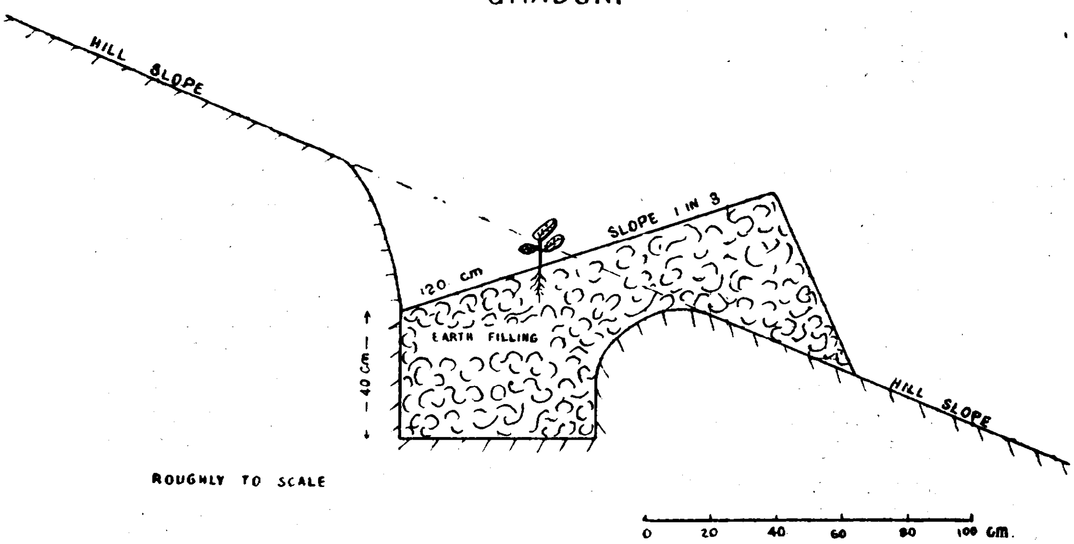
Fig. 4.- All areas under reafforestation are fenced with barbed wire.

Where "piazzuole" cannot be made because of the rocky nature of the ground, pits called "buche" are dug and plants put out in them.

It will be understood that in the best areas, where rocks are absent, there should be a regular uninterrupted series of "gradoni" and "piazzuole," while in the worst and most rocky areas only "buche" should occur. In practice, however, there is always to be found a combination of "gradoni," "piazzuole" and "buche," their proportions varying with the conditions of the locality. Figures 1—3 show the layout.

Figure 4 gives a close-up view of "gradoni."
(Also see Cross Section given below.)

CROSS SECTION OF
'GRADONI'



The depth of digging in a prepared "gradoni" is 40 cm. (or 16 inches) and its width between 100 and 120 cm. (40 to 48 inches); and the bed slopes 30 per cent inwards or, roughly, 1 in 3. The "gradoni" when made is thus actually a wedge-shaped trench but subsequently it becomes levelled out into the shape of a terrace. Plants are put out in the middle of the sloping bed. The reason for planting in the middle rather than in the bottom of the

trench or on the top of the bank is this: In a year or two the trench is gradually filled up by soil brought down by rain water from uphill and washed in from the bank: it becomes a terrace. If the plant were put out in the trench bottom its collar would be buried whereas on the bank its collar and possibly a part of the roots would be exposed. Both these conditions would be detrimental to growth. This is an important point. It is probable that by being in the middle the plants receive just the necessary amount of moisture. In Fig. 4 plants are seen in the middle of beds and also on the bank. The latter are in the nature of a second line of reserve sometimes considered necessary, particularly when direct sowing is done. Middle bed plantation is the general rule.

Contour trenches are laid out by means of a light staff about 10 feet long with a spirit level mounted at the middle. The foreman, who is generally a member of the Militia equivalent in rank to a Forest Guard, carries the staff and determines the line of advance. He is followed by a gang of five workmen whose duties are distributed as follows:

The first man marks the contour line by digging and slight banking.

The second man makes a 50 to 60 cm. wide terrace.

The third man extends the terrace to 100 to 120 cm.

The fourth digs the trench to a depth of 40 cm.

The fifth cuts to 30 per cent slope and finishes the bank.

Cost.—One such gang completes a 100 metre (or 325 ft.) long "gradoni" per day. Wages per man are 10 to 11 lire per day or roughly. Rs. 1-8-0. The cost works out to about 43 feet of "gradoni" for a rupee. If the calculation were made on the basis of a daily wage of 6 annas there would be 170 feet of "gradoni" for one rupee expenditure.

The average length of "gradoni" constructed per hectare ($2\frac{1}{2}$ acres) is 1,500 metres, or about 2,000 feet per acre.

The total cost of afforestation by the "gradoni" system, including the cost of rearing seedlings in the nursery and all other incidental items of expenditure, but excluding cost of the permanent staff, is 1,775 lire per hectare or roughly Rs. 100 per acre (92.5 lire =

£1 = Rs. 13 1/3). On the basis of a 6 annas wage it would work out to Rs. 25 per acre.

If, instead of "gradoni," only "buche" or pits are made then the cost per hectare is reduced to 1,275 lire or Rs. 75 per acre. But the mortality of plants in "buche" is 30 per cent., whereas in "gradoni" it is only 10 per cent. Before the introduction of the "gradoni" system all planting used to be done in "buche." It necessitated such large replacements that ultimately it was found to be costlier than "gradoni" planting. There is also a perceptible difference between the vigour of plants in "gradoni" and "buche" respectively, the former showing much more satisfactory growth.

Criticism.—The "gradoni" system has been criticised on grounds of cost. It has been said that it is prohibitively and unnecessarily costly; that "gradoni" are made closer together than they need be; that the plants could be more spread out; and that it would be possible by other methods to afforest a greater area for the same expenditure. As regards the cost, the figures given above will show that when work is well organised, as it is in Italy, "gradoni" does not cost too much. Regarding alternative methods of afforestation these have been tried in Italy and found not to answer so well and to be no cheaper in the long run. As for the spacing of "gradoni" it is bound to vary according to the conditions of the locality, for example, on steep slopes more "gradoni" are necessary than on gentle slopes; also on very hard and dry surfaces more "gradoni" must be made. So long as the chief functions of "gradoni" are kept in view, namely (1) to catch and allow to soak in as much rain water as is necessary to restore the soil to a moisture condition fit for supporting plant growth, and (2) to prevent loss of soil by run-off the optimum spacing can be worked out locally. What they are doing in Italy is what has been discovered by years of experiment and observation to be the irreducible minimum. The spacing of plants did, however, appear to the writer to be too close, but that perhaps is in order to obviate replacements by provision of ample reserves, and to have enough to choose from when conducting thinnings.

On Mount della Calvana the writer saw an actual example of the influence of "gradoni" on rain flow-off. Four years ago there used to be a big seasonal stream carrying down the water in a torrent when rain fell. Now it is a thin stream, almost a trickle. The Forest

Officer in charge said that diminution in run-off was noticed in the year following the making of "gradoni."

Policy of the State.—Areas have been classified according as afforestation is obligatory or only advisable. If obligatory, the land is either acquired outright by Government or taken over on lease for periods of 15 to 20 years. Wherever compact blocks of forest can be made acquisition is the rule. The process of acquisition is akin to the land acquisition procedure of India, but more drastic and rapid. Price differs according to the quality of the land; on Mount Subasio near Assisi, Central Italy, land which belonged to the Commune has been acquired at 300 lire per hectare or Rs. 17 per acre. The land is steep, bare and stony but not rocky.

Where the land to be afforested is honeycombed by agriculture or orchards, the acquisition of which would result in great hardship to the owners, the general rule is to take it over on lease. A small annual rental is paid to the owners equivalent to the money value of yield from grazing, etc., and certain taxes are also remitted. The area is fenced in with barbed wire. All works in connection with afforestation and tending the young crop are carried out at State expense. After 15 or 20 years the land and forest are given back to the owner free of charge but with the obligation that operates for all forests in Italy irrespective of ownership, namely, that the forest shall be properly managed. All private forests in Italy are under the control of Government, and rules and regulations have been framed in accordance with which all such forests must be managed. The Forest Department Staff exercise supervision.

Where afforestation is advisable but not obligatory landowners are induced by the grant of monetary assistance and remission of taxes to undertake it. In certain cases the State contribution towards the cost of afforestation is as high as 60 per cent.

As regards the species used, a very large number are being experimented with. For instance, pine, spruce, fir, oak and chestnut have been put out. Deodar (*Cedrus deodara*) was noticed to be thriving satisfactorily. Seed supplies are obtained from all parts of the world.

All afforestation areas are carefully fenced in with barbed wire. Fencing costs $1\frac{1}{2}$ to 2 lire per running metre or 1 to $1\frac{1}{2}$ annas per running foot.

General Information.—As a matter of general interest the following statistical information is appended:

Total area of Italy	...	31 million hectares	= 120,000 sq. miles.
Unproductive (Snows, rivers, etc.)		$2\frac{1}{2}$,, ,,	= 10,000 ,,
Productive ...	...	$28\frac{1}{2}$,, ,,	= 110,000 ,,
the last being composed of—			
Agriculture	...	53.8 per cent.	
Pasture and untended land	...	26.7 per cent.	
Forest	...	19.5 per cent.	
Population of Italy	...	About 40 million.	

Rainfall in Florence is about 800 mm. or 32 inches in the year; on high mountains it is as much as double this quantity. (In Vallombrosa at 4,000 feet altitude it is 1,300 mm.) More than a third of the total rainfall is confined to three months, October, November and December. June, July and August are months of the least precipitation, and there occur at that season short periods of intense drought destructive to plantations.

The temperature in Florence ranges from 42° F. minimum to 104° F. maximum.

The Forest Department, like several other departments, is organised on military lines and is known as Milizia Nazionale Forestale. Officers and men all hold military ranks like General, Colonel, Major, Captain, etc. There are in all 328 officers and 3,672 soldiers. Officers are appointed after an intensive course of Forestry at the Royal Institute in Florence. Sub-officers and soldiers receive training at a School at Vallombrosa where there is also an extensive arboretum containing an amazing collection of plants from all parts of the world.

Acknowledgments.—In conclusion I would take this opportunity to thank Mr. Oliphant, Director of the Imperial Forestry Institute, for his kindly interest and help; Prof. Aldo Pavari, Director of the Regal Stazione Sperimentale di Selvicoltura, Florence, for his most efficient arrangements and assistance; Dr. de Philippis, Assistant Silviculturist, who went to great trouble in accompanying the writer in all visits; Primo Senior Dr. P. Carloni, in charge

of Mount Subasio afforestation, who was good enough to show me personally round his operations, and to the other officers and men with whom I came in contact for their courtesy and help.

FOUR NEW SPECIES FROM ASSAM

BY C. S. PURKAYASTHA.

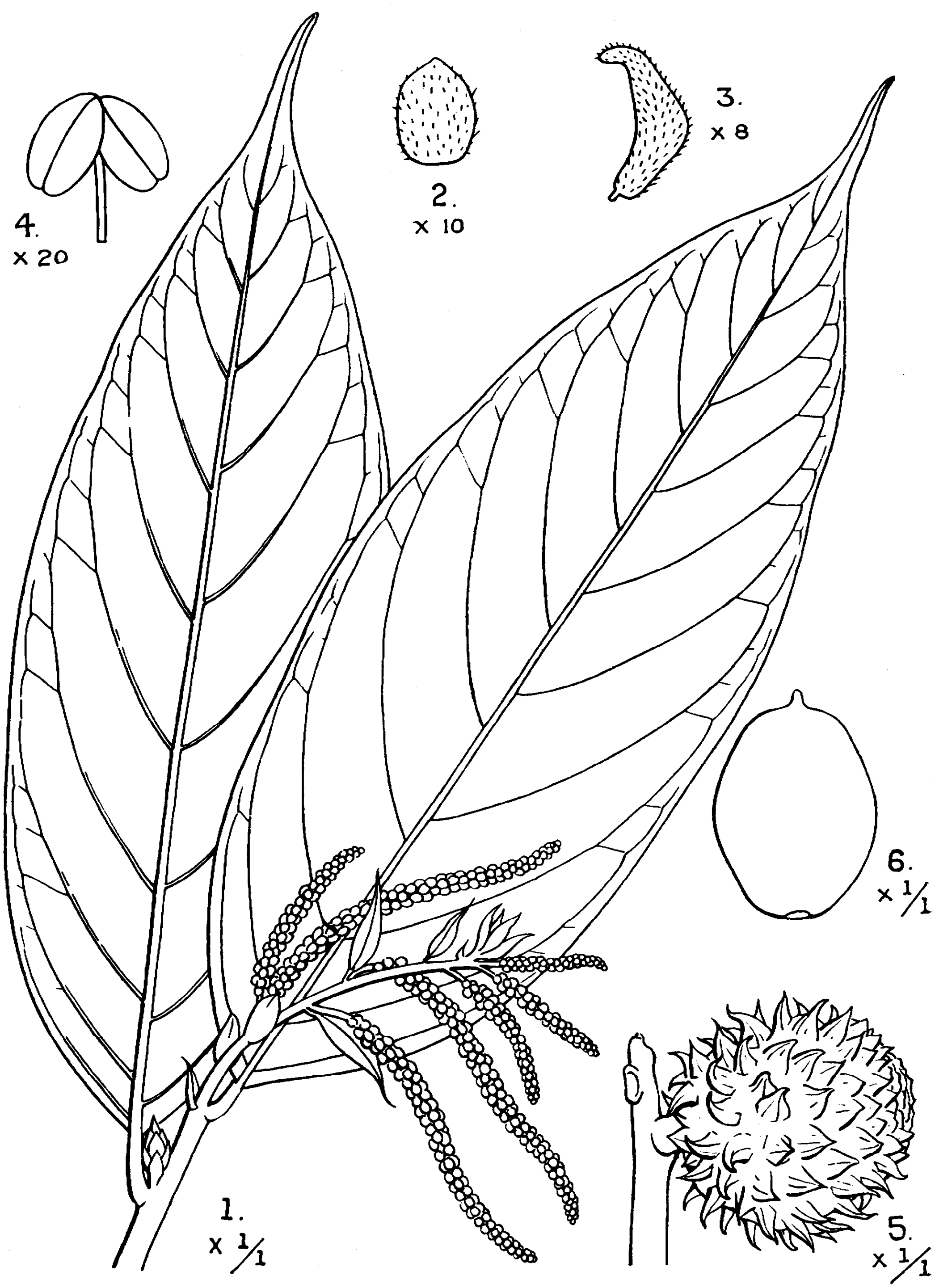
Quercus Milroyii Purkayastha sp. nov.

Fam.—Fagaceæ. Sec.—Lithocarpus.

Vern.—*Dabahingori,* Assamese; *Ta*, Abor.

Q. xylocarpae (Kurz) affinis, sed differt ab ea foliis majoribus, subter haud glaucescentibus, cuppa plerumque solitaria, elongato-ellipsoidea potius quam depresso-globosa; cuppæ in tecto tuberculis numero narioribus, brevioribus, crassioribus, in apices nec attenuato-explicatos nec reflexos extensis.

A large evergreen tree attaining a girth of 2-3 m. *Bark* greyish white, thin, reticulate and marked with close set, broad lenticels outside, inside marked with longitudinal raised stands. *Young shoots* villous. *Leaves* simple, alternate, 17.8—27.9 by 5.7—8.9 cm. oblong-elliptic, sometimes lanceolate, entire, long acuminate; base slightly decurrent on the petiole, at times oblique, glabrate above, underneath puberulous along midrib, chartaceous; lateral nerves 11-12, prominent beneath and impressed on the upper surface, curving near the edge and anastomosing. *Petiole* about 7.6 mm. pubescent. *Flowers* monœcious, male and female flowers in separate spikes. *Male flowers* in spikes crowded towards the tips of branches, bracteate; bract round to ovate, villous outside, glabrous inside, about 1.1 mm. across. *Flowers* minute, about 2.1-2.5 mm. across; perianth segments 6; stamens up to 12; anthers joined at the tip, diverging below; filaments short, torus cottony. *Female flowers* on erect, solitary, axillary spikes, 10 to 12 cm. long, few flowered, each flower in an involucre of loosely packed, fleshy, pubescent scales when young; perianth segments short. *Staminodes* few; ovary hairy; styles 3, hairy at the base, tip glabrous, recurved. Mature fruit generally solitary; drupe ellipsoid with a shallow depression at the top, 4 cm. by 3 cm. involucre completely



Ganga Singh

QUERCUS MILROYII Purkayastha.

enveloping the nut, outside marked with scattered, stout, short, more or less spirally arranged, conical, compressed tubercles sparsely distributed in the lower half but more or less crowded towards the tip. *Nut* Ovoid-ellipsoid, truncated at tip, crowned by the remains of the style, about 3.0 cm. by 2.6 cm.

ASSAM: N. E. Frontier Tract, Pasighat Res. 500—700 feet. Fls. 10-11. Fr. 7-8.

Kew confirms this as a new species. There is some similarity with *Quercus xylocarpa* Kurz but in this case the leaves are bigger and their lower surfaces are not glaucescent; the cupules are generally solitary, elongated-ellipsoid in shape instead of being depressed globose; the tubercles on the cupule covering are less numerous, shorter and stouter; the apices of the tubercles are not produced into spreading or reflexed points.

EXPLANATORY NOTE OF PLATE 22.

1 = Leaf specimen with ♂ spike.

2 = Bracts of the ♂ flower.

3 = Bracts forming the involucre of ♀ flower.

4 = Stamen.

5 = Cupule.

6 = Nut or glans.

Salacia Khasiana Purkayastha sp. nov.

Fam.—Celastraceæ.

S. Wrayii King affinis, sed foliis longioribus, elliptico-oblongis, subter glabris; inflorescentia axillaria haud extra-axillaria differt.

A large woody climber. *Leaves* simple, opposite, elliptic-oblong, 8.0—14.5 by 3.0—6.2 cm., entire; margin sometimes recurved; acuminate, base almost abruptly narrowing near the petiole, glabrous, subcoriaceous, lateral nerves 7-8 pairs with few less prominent intermediate nerves, arcuate, anastomosing near the margin. Petiole .6-1 .0 cm., margined. *Flowers* small, in clusters of 1—3 from axillary, bracteate tubercles, 3 mm. across. Pedicles about 3 mm. long. *Calyx* 5-partite; lobes unequal, thick, orbicular, about 1.5 mm. across. *Petals* free, persistent, 5, oblong, 2.5 by 1.2 mm. thickened in the centre. *Disk* fleshy, thick, angular, 2.0 by 1.0 mm, *Stamens* 3, continuous

with the disk, free portion of the filament .5 mm. long, twice bent in opposite directions supporting the anthers at the free end flat, dilated towards the base. *Ovary* 1.0 by 1.5 mm. 3 celled. *Style* .5 mm. long, free. *Berry* obovate in outline 4-5 by 3-4 cm. at the broad end, pericarp wrinkled, warty, seeds 4.

ASSAM, KHASI HILLS. 3-4,000 feet. Umteswar Forests.

Flrs. 7-8. Fr. Same time next year.

This species could not be matched at Kew or at the Sibpur Royal Botanical Garden herbarium. There is some similarity in fruit with Sheet No. 2542 of Sibpur which is identified as S. *Wrayii* King but the leaves and the inflorescence of this new species are quite distinct. In *S. Wrayii* King the leaves are much smaller, generally obovate-elliptic shining on the upper surface and the inflorescence is sometimes extra axillary, generally 3-6 flowered. Calyx segments broad reniform-ovate in the case of *Salacia Wrayii* King against orbicular in this new species.

EXPLANATORY NOTE OF PLATE 23.

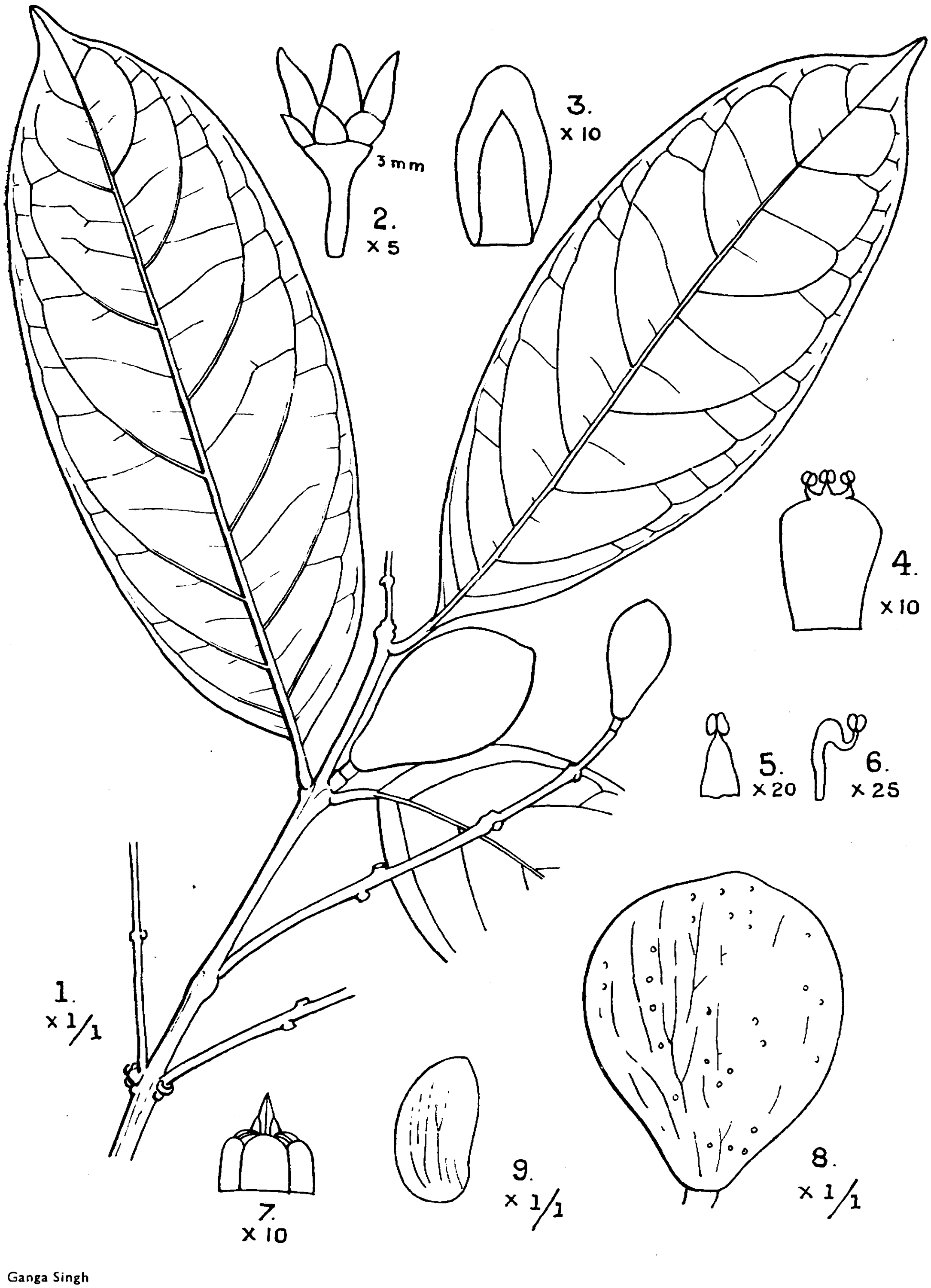
1. Leaf.
2. Flower.
3. Petal.
4. Disk showing the stamen and style at the apex.
5. Front view of the stamen.
6. Side view of the stamen.
7. Ovary with style.
8. Fruit.
9. Seed.

Purkayasthaea gen. nov.

Fam.—Lauraceae. Tribus.—Perseaceae.

Microporae Hook. f. affinis, sed ab ea antheris inclusis, 2-locellatis, locellis introrsum valvis oblongis, haud microporis, sursum dehiscentibus et stylo ovarii longe—attenuato perfacile distinguitur.

Arbores. Folia simplicia, alterna. Flores hermaphroditi. Perianthium 6-partitum. Stamina et staminodia perianthii tubo adnata. Stamina 6 perfecta perianthii lobis opposita, perianthio breviora; antherae introrsum 2-locellatae valvis sursum dehiscentes. Staminodia 12.



SALACIA KHASIANA Purkayastha.

Purkayasthaea pseudomicropora Purkayastha ex Narayanaswami (sp. unica)

Fam.—Lauraceæ.

Vern.—*Bonhingalo,* Assamese.

An evergreen middle-sized tree attaining a height of 20-21 m. and girth of about 2 m. with a spreading crown. *Bark* whitish grey, reddish inside. *Branchlets* marked with the scars of fallen leaves. *Young shoots,* buds and petioles of the leaves rusty pubescent. *Leaves* simple, alternate, crowded towards the ends of branchlets, 26-34 by 10-16 cm., obovate, apiculate, rarely rounded or retuse, cuneate, entire, rusty pubescent along the midrib on the upper surface otherwise glabrous, undersurface rusty pubescent, chartaceous; midrib prominent beneath, marked by a shallow depression above; lateral nerves 13-16, prominent beneath, directed upwards and connected by equally distinct intermediate veins. *Petiole* stout, channelled above, 1-1.4 cm. *Inflorescence* in axillary lax panicles; rachis 13-20.8 cm. in length, rusty tomentose. *Flowers* hermaphrodite, small, about 2.5 mm. long and 2.5 mm. across, campanulate. *Pedicel* about the same length as the flower, slightly dilated under the flower, tomentose. *Perianth tube* about 1.3 mm., coriaceous, pubescent outside and villous inside. *Perianth lobes* 6, imbricate, about as long as the perianth tube, elliptic-obovate, pubescent outside and villous inside. *Fertile stamens* 6, inserted on the perianth lobes and opposite to them, included; filaments very short, about half the length of the anthers, pubescent, flat; *anthers* introrse, short and thick, about 1.1 mm. long, two-celled, opening upwards from the base by valves; valves persistent. *Staminodes* in two rows of 6. The innermost row ovate in outline and villous, 1.6 mm. long, opposite to the stamens and closely appressed to the glabrous ovary; the second row glandular, alternating with the stamens, often attacked by larvæ of insects. *Ovary* about 1.3 mm. long, glabrous, ovoid, one-celled and one-ovuled. *Style* 1.3 mm. long, subulate. *Fruit* drupaceous with a hard rugose pericarp, 3 1-4.6 by 2.6-3.9 cm., obovate-elliptic in outline.

ASSAM: Digboi Res. Lakhimpur District, 300—500 feet.

Flrs. 8-9. Ripe fruit one year after flowering.

NOTE.—The specimen could not be matched either at Kew or Sibpur Royal Botanical Garden. When I first scrutinised the specimen I thought it might be a new species under the genus *Micropora* as described in Hooker's Icones Plantarum t. 1547 (1886) but while I

was finally describing the plant Mr. Narayanaswami of the Botanical Survey of India, officiating Curator, Royal Botanical Garden, Sibpur, suggested that it should be described as a new genus because it could not be included under *Micropora* which derives its name from the fact that the anthers dehisce by minute pores, whereas in this case they open by two valves.

EXPLANATORY NOTE OF PLATE 25.

1 = Leaf showing the inflorescence and the fruit.

2 = Flower.

3 = Portions of the perianth tube showing one stamen seated on a lobe and two glandular staminodes with the villous staminode removed.

4 = Anther before dehiscence.

5 = Anthers showing the persistent valves after dehiscence.

6 = Glandular staminode.

7 = Villous staminode.

8 = Ovary.

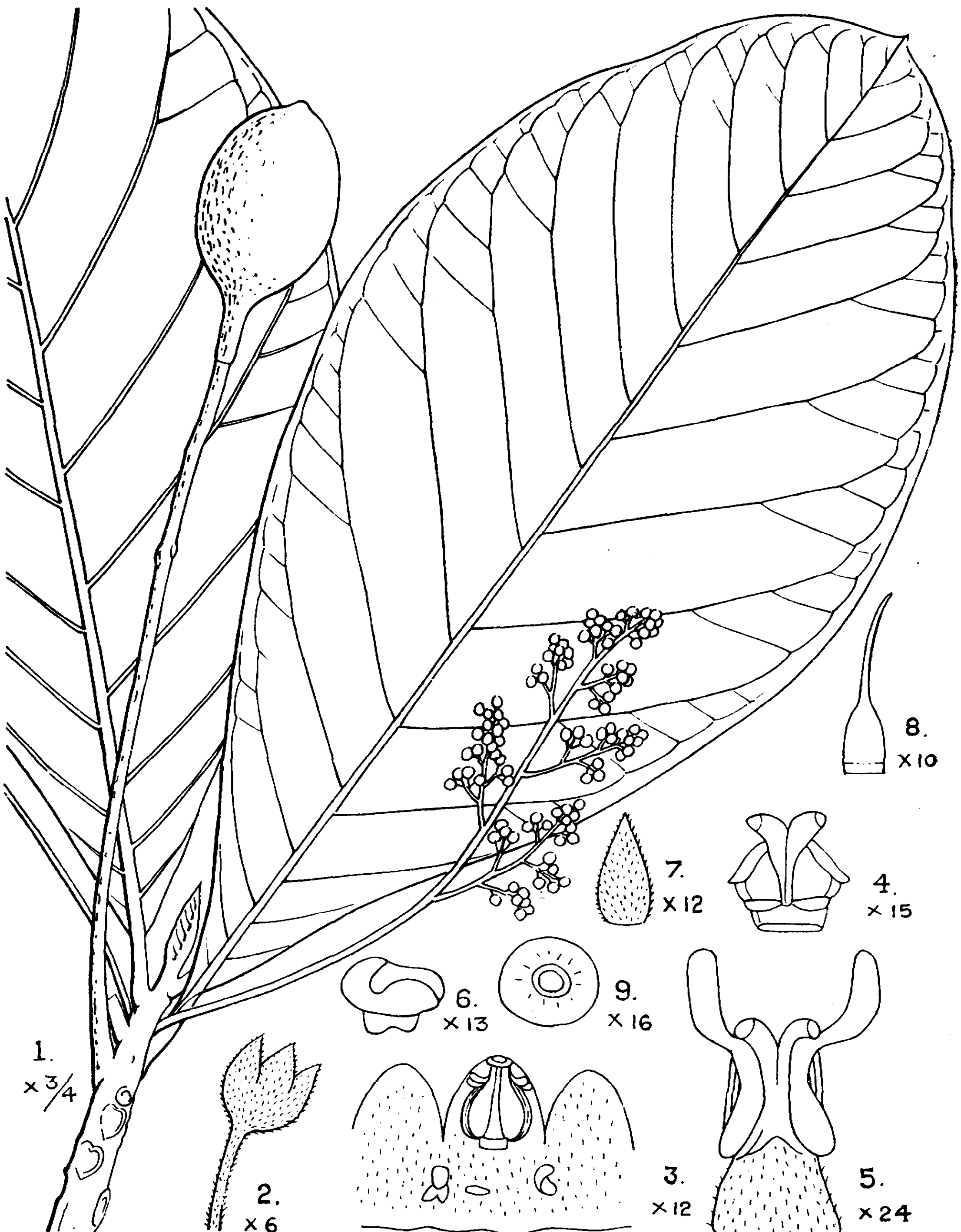
9 = Cross-section of the ovary with one ovule.

Ilex khasiana Purkayastha sp. nov.

Fam.—Ilicineae.

Arobr parva. *Ramuli* pubescentes, lenticellati. *Germina juvenilia* ferrugineo-tomentosa. *Folia* simplicia, alterna, elliptico-oblonga, 6.0—12.5 cm. longa, 30.—4.5 cm. lata, membranacea, serrato-crenata, acuminata, apex apiculatus vel mucronatus; basis rotundata interdum acuta, folii costa media pubescens, lamina alioquin puberulenta vel glabrata; nervi laterales utrinque 9—12, arcuati; *petiolus* 1.0—1.3 cm. longus, pubescens, supra excavatus.

Flores dioeci. *Inflorescentia* axillaris. *Pedunculi* et *pedicelli* pubescentes; *pedunculi* florum ♂ et ♀ plerumque minus quam 1.5 cm. longi; *pedicelli* florum ♀ ferme, .7 cm. longi et ei florum ♂ .2 cm. longi. *Calyx* 4 partitus; tubus 1 mm. longus; segmenta deltoidea, 5 mm. longa et basi 1 mm. lata; margo erosa nonnunquam paene ciliolata. *Petala* florum ♂ et ♀ basi connata; corolla rotata; tubus ferme .5-1.0 mm. longus; lobi 4 raro 3, oblongi, obtusi, 1.5-2 mm. lati et longi, *stamina* et *staminodia* lobis corollae isomera, tubo florum ♂ et ♀ laeviter adhaerentia; antherae 1.0—1.25 mm. longae, locelli inaequales, divergentes; filamenta antheris aequalia. *Pistillodum* superne bifidum. *Ovarium* ovoideum, 2.0 mm. longum, 1.5 mm. latum, stigma sessile. *Fructus* ovoideo-globosus, drupaceus, ferme



Ganga Singh

PURKAYASTHAEA PSEUDOMICROPORA Purkayastha.

Ganga Singh

ILEX KHASIANA Purkayastha.

6 mm. longus, 4 mm. latus, 4-pyrenus; pyreni crustacei, 1—spermi, trigonales.

ASSAM KHASI HILLS. 4—6,000 feet.

Flr.—5—7. Fr.—10—12.

A small tree. *Young shoots* pubescent, marked with small lenticels. *Leaf buds* rusty tomentose. *Leaves* simple, alternate, elliptic-oblong, 6.0—12.5 by 3.0—4.5 cm. membranous, serrate-crenate, long acuminate ending in an apiculate or mucronate tip; base rounded, at times acute; pubescent along midrib, otherwise puberulous or glabrate; lateral nerves 9-12 pairs, arcuate towards the end anastomosing near the margin. Petiole channelled above, 1.0—1.3 cm. long, pubescent. *Flowers* dioecious, 1.5 mm. in diameter in bud and 3.5 mm. when open, in simple or dichotomously branched, peduncled umbellules coming out from the leaf axils and sometimes from the scars of fallen leaves. *Peduncles* and *pedicels* pubescent. *Peduncles* rarely exceeding 1.5 cm. in length in both ♂ and ♀ flower. *Pedicels* about .7 cm. in ♀ flower and .2 cm. in ♂ flower. *Calyx* 4-partite; tube about 1 mm. long; segments deltoid, .5 mm. long and 1.0 mm. at the base, margin erose, at times almost ciliolate; persistent. *Petals* connate at the base in both sexes, rotate; tube about .5—1.0 mm. long; corolla lobes 4 rarely 3, oblong, obtuse, 1.5—2 mm. broad, as long as it is broad. *Stamens* in ♂ and *staminodes in* ♀ as many as the corolla lobes, adnate to the corolla in both sexes; *anthers* 1.0—1.25 mm. long in ♂ flower; cells unequal, diverging; filaments as long as the anthers. *Pistillode* bifid at the top. *Ovary* ovoid, 2.0 by 1.5 mm.; stigma sessile. *Drupe* ovoid-globose, about 6 by 4 mm. with 4 convex, trigonous stones, about 4-5 mm. long.

NOTE.—The species could not be matched either at Kew or Sibpur.

EXPLANATORY NOTE OF PLATE 24.

0 = Leaf with inflorescence.

1 = Part of calyx.

2 = Corolla opened out with stamens.

3 = Stamen.

4 = Staminode.

5 = Ovary.

6 = Stone.

7 = Leaf with female flowers.

ALL OVER A FEW SAL LOGS

BY S. A. A. ANVERY, I. F. S.

Nawab Safdarjang, the forerunner of the Oudh kings, was a favourite courtier at the Mogul Durbar of Delhi. He was already the hereditary Subedar of Oudh and now the Subedari of Kashmir was also bestowed on him. In 1746 A.D. he required sal logs in connection with a big construction scheme that was to be carried out at Delhi and sent his engineer to procure them from the submontane tracts of Kumaon, the present Kalagarh, Ramnagar and Haldwani Forest divisions of the United Provinces. This part of the country was under the Rohilla clan of the Pathans of whom Nawab Ali Mohammad Khan was the leader at that time. The Nawab's soldiery harassed the Delhi engineer so much that he had to go back, leaving all the felling work in the middle, where he told his tale of woe to his master. This was the beginning of the enmity between the Oudh Vazirs and the Rohillas which at last resulted in the extermination of the latter.

Safdarjang began to poison the ears of H. M. King Mohammad Shah of Delhi against the Rohilla chief and in the end he succeeded to such an extent that the king in person launchd an offensive against Ali Mohammad Khan. Umdatul Mulk, the Prime Minister of Delhi was, however, on bad terms with Safdarjang and therefore against all his proposals. In this war too the premier wanted to discredit Safdarjang and was thus against the war itself. He got his opportunity when the Imperial artillery proved futile in the dense bamboo forests of Bangarhi, where Nawab Ali Mohammad Khan had collected his forces, and spoke to the king about the uselessness of the campaign. The Rohillas, on the other hand, became themselves tired of war. With the help of Qaim Khan Bangash, Subedar of Farrukhabad, and through Umdatul Mulk, the premier, they sought the Emperor's forgiveness, which was granted. This was not what Safdarjang wanted. He became irritated at the miscarriage of his plans. In addition to the enmity towards the Rohillas he now began to entertain hatred towards the Bangashes (another clan of the Pathans) at whose intercession his scheme fell through.

In time Ahmad Shah ascended the throne of Delhi while Nawab Ali Mohammad Khan Rohilla died in Rohilkhand, leaving Sadulla

Khan, his son, as the leader of the Rohillas. During this time Ahmad Shah Abdali came down from the north-west and made his first attack on India. In this war Safdarjang excelled all others in his selflessness and loyalty to the throne and was mostly responsible for successfully repelling the foreigners. Safdarjang was rewarded lavishly and was raised to the premiership. Now was his chance to deal with the Rohillas as he pleased. He hit upon an ingenious plan by which he hoped to divide the Bangashes and the Rohillas and set up one against the other. He refused to recognise Sadulla Khan, son of the late Nawab Ali Mohammad Khan, as the Subedar of Rohilkhand and wrote to Qaim Khan Bangash, bestowing the Rohilla districts on him and directing him to take possession of them with force if necessary. This bait proved too much for the Bangashes to resist and Qaim Khan Bangash marched against the Rohillas in 1163 A. H. Unfortunately, Qaim Khan was himself killed in this battle and thus Safdarjang's scheme of simultaneously annihilating the two Pathan clans again proved fruitless. He, however, took advantage of Qaim Khan's death and somehow prepared the king to take over the Bangashe's fief and give it to Safdarjang's assistant, Newal Rai of Lucknow. This Newal Rai was a particularly inhuman and depraved upstart. He caused untold miseries and humiliations to the proud Pathans which naturally resulted in a rising against him under Ahmad Khan, brother of the late Qaim Khan, in which Newal Rai was killed. This enraged Safdarjang who came with the marauding Jats of Bharatpur to lay waste the whole country of the Bangashes. Ahmad Khan, however, fought desperately and repulsed the Imperial armies. The design of Safdarjang had, by now, become transparent to both the Bangashes and the Rohillas, who saw safety only in joining hands against him. Thus sometimes after, when Safdarjang returned to take his revenge he saw the Bangashes and the Rohillas united against him. But he was prepared for all eventualities. In addition to the Mogul army, there were with him Jats from Bharatpur, Rajputs from Rajputana and the Mahrattas whose services were acquired for a crore of rupees. Hostilities continued for a long time in which the allied armies were very much harassed but the superior numbers proved effective and the Pathans were defeated and Ahmad Khan Bangash fled with Sadulla Khan Rohilla to Aonla in the Rohilla territory. But this only resulted in diverting the attention of the allied armies towards Rohilkhand, the first objective of Safdarjang. The Pathans put

up many a brave fight but had to run away because heavy odds were against them. They fled towards Moradabad and Kashipur and took shelter in the forests. Hamilton says that they took refuge in the Laldhang forests (District Garhwal) but this is not supported by history. The authors of *Gulistan-e-Rahmat, Muntakhibul Ulum and Tabqatush Shura* all are unanimous that the place of refuge was Chakia in Kumaon (situated in the present Ramnagar Forest division of the United Provinces). The date of this episode is preserved for us in the chronogram *"Fisad-i-Azim"* (The Great Calamity). Safdarjang with his allies tried his level best to pursue and dislodge the Pathans from the forest fastnesses but in vain. He began to fell the forest on a large scale but instead of clearing the way hindered his own progress because the fallen logs proved formidable barriers to the advancing army. In the meantime Ahmad Shah Abdali came down from Kabul a second time. Safdarjang had, therefore, to conclude a treaty with the Pathans in 1165 A. H. and he went back to Delhi. This is known as the "Treaty of Chakia." Under this treaty both the parties professed friendship to each other and agreed to help one another in case of an attack by a third party.

This treaty, however, was not respected for long. Safdarjang died and was succeeded by his son, Shuja-ud-daula, to the Vizarat of Oudh. Shuja-ud-daula also inherited from his father his hatred towards the Pathans. The Delhi court had more or less lost its controlling power over the provinces now, and Hafiz Rahmat Khan Rohilla had become the virtual ruler of Rohilkhand. By far the most important power in the country was that of the Mahrattas who used to raid northern India with impunity. In 1772 A. D. the Mahratta's objective was Rohilkhand. Hafiz Rahmat Khan became nervous and entered into an agreement with Nawab Shuja-ud-daula of Oudh by which the Nawab agreed to help him against the Mahrattas and Hafiz Rahmat Khan, on his part, promised to pay Rs. 40 lacs to the Nawab for his help. This agreement was witnessed by Sir Robert Barker. Shuja-ud-daula wanted to serve a double purpose, his main object being somehow to get a footing in Rohilkhand. But when the Mahrattas heard of the alliance they bolted away without giving any fight. Shuja-ud-daula demanded of Hafiz Rahmat Khan his 40 lacs and the latter began to make excuses. Now Shuja-ud-daula offered the same amount to the English for help against the Rohillas. Lord Warren Hastings agreed to it and sent

his army under Colonel Champion to the Oudh Nawab. The allied forces attacked the Rohillas at Miranpur Kara where Hafiz Rahmat Khan was killed and the Rohillas were defeated in a fierce fight. The allied forces laid waste the whole country in a manner which hardly has an equal in Indian history. Colonel Champion's description and Lord Macaulay's statement in the Parliament are enough to give the reader an idea as to what it meant to the Rohillas and their country. In spite of all this the Rohillas did not surrender and withdrew to their tried friend, the forests. This time they took refuge in the Laldhang forests of district Garhwal. Shuja-ud-daula wanted to annihilate the Rohillas completely and pursued them up to Najibabad and Pathargarh but the advance guard found themselves in unsurmountable difficulties and reported:—"Laldhang is about 25 miles from this place and the way is full of dark jungles. Tall *kans* grass abounds and the thick *dhak* and bamboo forest is so dense that the approach to the Rohillas is well nigh impossible. Cutting the forest is neither practicable nor will it help us in any way." Shuja-ud-daula would have kept up the campaign in spite of this report, had not Warren Hastings recalled Colonel Champion and his company back to Calcutta. Warren Hastings had had his 40 lacs and there was nothing more for him to gain by leaving the English army with the Nawab. Shuja-ud-daula had, therefore, to conclude a treaty with the Rohillas in a hurry and the Rohillas returned from Laldhang in 1775 A. D. The present State of Rampur was given back to the nephew of the late Hafiz Rahmat Khan, and the rest of his territory was confiscated.

When Warren Hastings was indicted before the Houses of Parliament in 1785 A. D., the annihilation of the Rohillas out of greed for money was one of the charges against him.

Asaf-ud-daula succeeded Shuja-ud-daula and he also succeeded to the hereditary hatred towards the Rohillas. He was always on the lookout for an opportunity to pounce upon them. He got this opportunity in 1209 A. H. when the question of succession to the Rampur *gaddi* arose. Asaf-ud-daula interfered uninvited. The English interest also demanded the amalgamation of the Rampur State with the Oudh Vizarat. Hence the combined forces of the English and the Nawab advanced against the Pathans. General Abercromby was commanding the English forces. The two opposing

armies met at Moza Bithora and a very fierce engagement ensued. Captains J. Moby, Mordaunt, Wells, Plumer, Richardson and 15 more officers were killed but the day ended with a victory for the British and the Oudh Nawab. The Pathans fled to the jungles of Rehar and Jaspur (now in the Ramnagar Forest division of the United Provinces) and took shelter there. The armies of Asaf-ud-daula and the English pursued them up to Tappa and laid seige. The seige prolonged and tired the Pathans on the one hand while malaria broke out in the English armies on the other. This hastened the parties to arrive at an agreement and the result was the "Treaty of Tappa" according to which Nawab Ghulam Mohammad Khan surrendered himself to General Abercromby and agreed never to go back to Rampur. He consequently went to Mecca in 1212 A. H.

This was the end of the Pathan power in Rohilkhand but even to-day the Pathans are by far the major part of the Muslim population of these districts. They must thank the forests for their existence for had it not been for the forest which protected them and gave them refuge whenever they fled for life, they would have found themselves standing against the wall and everybody in the world with his sleeves up and flying to their throats; they would have failed entirely to resist the terrible onslaught of the Moguls, the Oudh Vazirs, the Mahrattas, the Jats, the Rajputs and the English.

ELEPHANTS

Extracted by Khan Sahib S. R. Daver, 4.F.O., Bastar Estate.

From "Ayeen Akbery"—BY ABUL FAZIL

(*Translated by Mr. Francis Gladwin in* 1783, *pages* 95 *to* 102)

The natives of Hindustan hold this animal in such estimation that they consider one of them as equivalent to five hundred horses. The male elephant is of so generous a disposition that he never injures the female although she be the immediate cause of his captivity; neither will he fight with a male who is much younger than himself, and from a sense of gratitude, he never hurts his keeper; and out of a respect for his rider, he never blows dust over his body when he is mounted, although at other times he is continually amusing himself with so doing. In the rutting season an elephant was fighting with his match, when a young one coming in their way, he very

kindly set him aside with his trunk, and then renewed the combat. If a male elephant breaks loose in the rutting season, nobody dares go near him without being accompanied by a female one, and then he suffers himself to be bound without offering any resistance. When the female dies, the male will neither eat nor drink for a considerable time. He can be taught various feats. He learns the modes, which can only be understood by those skilled in music, moves his limbs in time thereto. He is also taught to shoot an arrow out of a bow, and to take up anything that is thrown down, and to give it to his keeper. He is fed with any kind of grain wrapt up in grass; and what is very astonishing, upon a signal being given him by his keeper, he will hide eatables in the corner of his mouth, and when they are alone together, will take them out again and give them to the man. An elephant frequently with his trunk takes water out of his stomach, and sprinkles himself with it and it is not in the least offensive. Also he will take out of his stomach grass on the second day, without its having undergone any change.

The price of an elephant is from one hundred, to a lakh of rupees. Those of five thousand, and of ten thousand rupees price, are not uncommon.

There are four kinds of elephants. Behder is that which has well proportioned limbs, an erect head, broad breast, large eyes, and a long tail, with two excrescences in the forehead resembling large pearls. These excrescences are called in the Hindovee language Guj Manik, and many properties are ascribed to them. Another kind called Mund, has a black skin, and yellow eyes; is bold and ungovernable. That called Murg, has a whiter skin, with moles, and its eyes are of a mixture of red, yellow, black and white. That called Mirh has a small head, and is easily brought under command. Its colour is a mixture of white and black resembling smoke. And from mixtures of the above kinds are formed others of different names, and properties.

The Rej Tum, of whom a particular description shall hereafter be given, is very common. And this kind is handsome, well proportioned and tractable, has not much inclination for the female, and is very long lived. The Beysh Rej has a dreadful piercing eye with a tremendous countenance, has a ravenous appetite, is vicious and sleeps a great deal.

Formerly it was thought unlucky to allow tame elephants to breed; but His Majesty has surmounted this scruple.

The female goes with young eighteen lunar months. The foetus begins to have some form in the eleventh month; in the twelfth month the veins, bones, nails and hair are discernible; in the thirteenth month its sex may be discovered; and in the fifteenth it has life. If the female increases in strength whilst breeding, it is a sign that she is big of a male; and on the contrary, if she is weak, it indicates her having a female. In general an elephant has but one young at a birth; but sometimes she has two. The young one sucks till it is five years old after which time it feeds on vegetables. At this age it is called Bal. At ten years it is called Powt; at twenty Bek; and at thirty Kelbeh. It undergoes some change at every one of these periods and arrives at maturity in sixty years. It is a good sign in an elephant to have eyes of yellow and white mixed with black and red. The elephant has two tusks, an ell in length, and some times longer. The tusks are said to be sometimes red, and likewise four in number. An elephant ought to be eight cubits high and nine in length, and should measure ten cubits or more round the back belly, and white specks on the forehead are very lucky.

The male elephant wants the female in different seasons; some in winter, some in summer, and others in the rains. And at this time they commit many extravagancies, throwing down houses and stone walls and pulling men from on horseback with their trunks. The sign of their being hot, is a filthy water, of a white or red colour, exuding from their temples and which is of an insufferable smell. Each of the temples of an elephant is said to have twelve perforations. Before this symptom, the elephant is outrageous, and looks very handsome. The natural life of an elephant, like that of a man, is one hundred and twenty years. The elephant has many general names, amongst which are Husty, Guj, Feel, Peel and Hawtee. An elephant by being properly trained may be made very valuable so that many who buy an elephant for an hundred rupees, in a short time make him worth ten thousand.

Elephants are taken in the following places: In Agra, in the wilds of Begawan, and Nerwar, as far as Berar; the subah of Allahabad; near Ratanpur, Nunderpur; Sirgetchen; the subah of Malwai; Hatandeyah; Achowd; Chundary; Suntwass; Bijehgur; Roysayn;

Hosangabad; Gurh; Haryehgurh; in the subah of Behar on the borders of Rohtas; at Jahrkhend; and in the subahs of Bengal and Orissa, particularly at Satgong, there are great numbers. The best elephants are those of Tepperhah.

A herd of elephants is called in Hindovee language Sehan, which word is also applied to a thousand.

His Majesty has introduced many wise regulations into this department.

He first parcelled out the elephants, committed some to the Daroghahs, and appropriated others to his own particular use. He arranged the elephants in seven classes. First, Must, which is an elephant that is arrived at perfection. Second, Sheergeer, is an elephants used in war, and who has been rank once or twice, and is always so in some degree. Third, Sadeh, is one that is somewhat younger than the second. Fourth, Menjholeh, is smaller than the one next preceding. Fifth, Kerheh, is of a size smaller than the fourth. Sixth, Benderkeeah is a little smaller than the fifth. Seventh, Mukel is a young elephant that has never been rode. And each of these are subdivided into three kinds; excepting the seventh rate which is subdivided into ten kinds; and a proper quantity of food is fixed for each, as is set forth in the following table of daily allowance:—

			Mds.	Srs.
	Must.			
Large	...	...	2	24
Middling	...	...	2	19
Small	...	...	2	14
	Sheergeer.			
Large	...	...	2	9
Middling	...	...	2	4
Small	...	...	1	39
	Sadeh.			
Large	...	...	1	34
Middling	...	...	1	29
Small	...	...	1	4
	Menjholeh.			
Large	...	...	1	22
Middling	...	...	1	20
Small	...	...	1	18

Kerheh.

			Mds.	Srs.
Large	...	...	1	14
Middling	...	...	1	9
Small	...	...	1	4

Banderkeeah.

Large	...	...	1	0
Middling	...	...	0	36
Small	...	...	0	32

Mukel.

First	...	...	0	26
Second	...	...	0	24
Third	...	...	0	22
Fourth	...	...	0	20
Fifth	...	...	0	18
Sixth	...	...	0	16
Seventh	...	...	0	14
Eighth	...	...	0	12
Ninth	...	...	0	10
Tenth	...	...	0	8

The female elephants are of four classes, large, middling, small and Mukel; the first and second of which are each subdivided into three kinds, and the Mukel into nine kinds. Their daily allowances are as follows:

Large.

			Mds.	Srs.
First	...	...	1	22
Second	...	...	1	18
Third	...	...	1	14

Middling.

First	...	...	1	10
Second	...	...	1	6
Third	...	...	1	2

Small.

First	...	...	0	37
Second	...	...	0	32
Third	...	...	0	27
Fourth	...	...	0	22

Mukel.

	Mds.	Srs.
First	0	22
Second	0	20
Third	0	18
Fourth	0	16
Fifth	0	14
Sixth	0	12
Seventh	0	10
Eighth	0	8
Ninth	0	6

Establishment of servants for the elephants

For a Must there are allowed five men and a boy. Thus one Mehawet, one Bhuy, three Mayhets, and a boy. The business of the Mehawet is to ride upon the neck of the elephant, and to train him. His monthly wages is 200 Dams. The Bhuy sits upon the rump of the elephant, and assists in battle and in quickening the speed of the elephant; his pay is 110 Dams per mensem. The Mayhet fetches fodder, assists in caparisoning and undressing the elephants, etc. On a journey he receives four Dams, and at other times three and a half Dams daily.

The Sheergeer has five men, *viz.*, one Mehawet, one Bhuy, and three Mayhets; the first has 180 Dams, the second 100 Dams per mensem, and the others as before mentioned.

For the Sadeh are allowed four men and a boy, *viz.*, a Mehawet at 160 Dams, a Bhuy at 90 Dams per month, and two Mayhets and a boy at the established rate.

The Menjholeh has four servants, *viz.*, a Mehawet at 140 Dams, a Bhuy at 80 Dams monthly; and two Mayhets at the established rate.

The Kerheh has three men and a boy, *viz.*, a Mehawet at 120 Dams, a Bhuy at 70 Dams per month, and a Mayhet and a boy at the established rate.

The Banderkeeah has a Mehawet at 100 Dams per month, and one Mayhet at the established rate.

The Mukel has a Mehawet at 50 Dams per month and a Mayhet at the established rate.

The following is the establishment of servants for the female elephants:

For the largest size four men, *viz.*, a Mehawet at 100 Dams, a Bhuy at 60 Dams per month, and two Mayhets at the established rate.

For the middle size, three men and a boy, *viz.*, a Mehawet at 80, and a Bhuy at 50 Dams per month, and a Mayhet and a boy at the established rate. For the smaller size, a Mehawet at 60 Dams per month and a Mayhet at the established rate. For the Mukel, a Mehawet at 50 Dams per month and a Mayhet at the established rate.

At first His Majesty formed ten, twenty or thirty elephants into a troop, which is called a Hulkah, and the person to whose charge it is committed is called a Foujdar. The Foujdar's business is to teach the elephants to be bold, and not to be frightened at the sight of fire or at the noise of artillery; and he is answerable for their discipline in these respects.

Every Munsubdar of 100 or more has twenty-five or thirty elephants appointed for him. And the other Foujdars who are Bisties or Dehbashies are under his command; and this goes on progressively from a Dehbashy to an Hezary, and the pay after the Subdies are different; and many are of the rank of Omrahs. A suddy has two marked horses.

In the rank of Bisties.

		Rs. per month.
The first has	...	30
The second	...	25
The third	...	20
Of the Dehbashies.		
The first has	...	20
The second	...	16
The third	...	12

But the Bisty and the Dehbashy, who has one marked horse is reckoned amongst the Ahdyan. Each Foujdar, who is appointed to twenty-five or thirty elephants, pays the wages of the Mehawet and Bhuy of the elephant which he uses for his own riding. And he who has charge of ten or twenty elephants pays the wages of one Mehawet. Afterwards, His Majesty, not satisfied with this method, gave a Hulkah of elephants in charge to an Emeer, and ordered him to superintend it. The food is provided by assignments on government, and a clerk is appointed to keep the accounts of the receipts and expenditures of the department, and to see the royal regulations carried into execution.

REVIEWS

REPORT ON FOREST ADMINISTRATION IN ASSAM FOR 1936-37

The Assam Annual Report for 1936-37 records a sad page in the history of the forest administration of the Province as during the year the Service lost its popular and able Conservator. An obituary notice reprinted from the Bombay Natural History Society's Journal, and included in the report, dwells on the great services which Milroy rendered to the cause of game preservation in Assam, and to the wonderful charm of personality which he possessed. Officers of other Provinces who had the fortune to meet Milroy will fully sympathise with Assam in its great loss.

The revenue surplus for the year was Rs. 4,92,000 compared with Rs. 3,56,000 in the previous year. Any congratulations on such a result which the reader may be tempted to give are somewhat damped by the fact that, of the increase in surplus of Rs. 1,36,000, the sum of the Rs. 1,07,000 represents a reduction in outstandings on account of revenue as compared with the previous year. The report states that the increased revenue was due to brighter trade conditions and to the activities of the Forest Utilisation Officer, but the reader is left in the dark as to what those activities were. The expenditure figures include an item of Rs. 54,000 representing interest on capital outlay. During the year capital expenditure rose from Rs. 33,000 to Rs. 64,000, owing to the purchase of an engine for the Goalpara Tramway and the provision of necessary quarters for the staff.

Of the total area of reserved forests and areas reserved under executive order of 6,652 square miles, 3,171 square miles are under sanctioned Working Plans or schemes, while plans are in preparation for a further 1,709 square miles. This welcome expansion in Working Plan activity will do much to remove the former backwardness of the Province in this respect. It is welcome to note that the Assam Government has issued orders that the Assam Saw Mills and Timber Company, which had hitherto been allowed to work in defiance of Working Plans prescriptions, must adhere to the prescriptions in the coming plan.

Assam is somewhat notable for the small area of 38 square miles which is under fire protection. It is stated that experiments are being made with early fires in plantation areas old enough to stand them, so as to reduce the area under protection and consequent costs.

The report confirms last year's statement that there is now no apprehension that the sal forests of the Province will disappear because of any lack of the technical method whereby they can be regenerated. The technique followed, which is largely due to Milroy's efforts, consists in scientific burning, rains tending and rains weeding, either singly or in combination. For plantation areas ten-year schemes, prescribing tending and thinning operations and minimum areas to be planted, were under preparation for all divisions. The difficulty of finding labour for performing tending operations in *taungya* operations led to a reduction in the area of new plantations of this nature. The report draws attention to this decrease and to the increase in the area of regular plantations, but supplies no figures in support of the statement.

The Chapter on exploitation does not present a clear picture of this aspect of the activities of the department. Under the sub-head "System of management" an account, which reads like a clerical abstract of divisional reports, is given of the system and agency of exploitation in each division. Assam, like other Provinces, appears to find difficulty in separating the information which should be given under the sub-head referred to, and under "Agency of Exploitation." Some general change in the present system of classifying information seems indicated.

During the year the Kachugaon Tramway carried 1,34,000 c.ft. of timber of contractors compared with 1,16,000 c.ft. in the previous year. The increase was imputed partly to freight reductions on logs. A certain amount of timber was treated by the Assam Oil Company, and the report expresses the hope that the Assam Railways and Trading Company would reopen their sleeper treatment plant this year. 50,000 M. G. sleepers were supplied to the B. N. Railway through contractors by the Utilisation Officer. Royalty on lac rose from Rs. 75,600 on 33,550 maunds in the previous year to Rs. 79,800 on 48,642 maunds. It is interesting to note that of the total value of produce removed by right holders, free-grantees and at privileged

rates of Rs. 1,65,000, Rs. 1,01,000 represents Minor Forest Produce, and of the latter sum Rs. 91,000 is due to canes and thatching grass.

Research work appears to have been confined to botanical research due to the present incomplete knowledge of the flora of Assam.

Preservation of Wild Life and Elephant Control is given a Chapter to itself—evidence of the interest which the department takes in this side of its activities. New Shooting and Fishing Rules, to come into force from 1st June 1937, were issued by Government. The amendment of the Acts and Rules controlling shooting outside the Reserved Forests was taken up by the local Government. Proposals to establish a wild buffalo reserve, to be named in Milroy's memory, were under consideration. During the year, as a result of Mela and Kheddah Shikar operations, 571 elephants were captured, of which 143 were released and 23 died or were shot. The revenue realised totalled Rs. 58,000. Royalty was levied at the rate of Rs. 125 for Makhnas and Rs. 200 for females and tuskers. Government's net surplus on account of Kheddas was Rs. 31,000, the average sale price being Rs. 573. The problem of rogue elephants and crop destruction is being dealt with by the issue of free licences to approved and properly armed sportsmen, the licensee being allowed to keep a pair of tusks for each Makhna destroyed. 48 elephants were thus accounted for, but the report states that the benefits of the system were not fully grasped. "Suggestions are still made for the increase of crop protection guns which in fact, so far from having any effect in reducing the number of *gundas*, rather tends to increase the danger since by wounding the marauders, and causing untold suffering, subsequent attacks become more hostile, occasionally resulting in loss of life in addition to crop damage." Other Provinces in India where elephant damage is considerable may well take note.

J. W. N.

EXTRACTS

INDIAN TIMBERS

**Chapter IV of the Report of the Indian Trade Commissioner, London, for the year ending March 1937.*

Imports of unmanufactured timber to the United Kingdom from all sources of supply during 1936 compare as follows with those of 1935 and the average imports of the 5-year period, 1926 to 1930:

	Quantities in Thousands of Cubic Tons			
	Average 1926-30.	1936.	1936.	Imports of 1936 compared with the average of 1926-30.
Hardwoods (hewn and sawn) ..	731	777	861	+ 130
Softwoods (hewn and sawn)	5,477	5,925	7,046	+ 1,569
Other descriptions ..	3,567	3,944	3,882	+ 315
Total ..	9,775	10,646	11,789	+2,014
Total value (£ Thousands)	44,020	35,516	43,568	— 452

NOTE.—The figures for other than hardwoods are approximate only in view of the different denominations used to express quantity.

Imports of manufactures of wood and timber during 1936 were valued at £7,462,690. These include 14,292,347 cubic feet of plywood valued at £4,127,375.

The above figures are given to illustrate the large quantities of timber required annually in the United Kingdom in addition to the home-grown timber output, estimated at 750,000 tons.

The volume of timber imported during 1936 was a record.

Timber imported into the United Kingdom from India during 1936 compares as follows with the imports of 1935 and the average

* Chapter written by Sir H. W. A. Watson, Timber Adviser to the High Commissioner for India.

imports of the five years, 1926—30:

	Quantity in tons of 50 cubic feet. Average 1926—30.	1935.	1936.
Teak	34,634	36,436	46,625
Hardwoods other than teak ...	2,552	2,549	3,332
Miscellaneous		95	114
Total ...	37,186	39,080	50,071
Total value £	971,800	682,965	956,035

NOTE.—The information for 1936 is Crown copyright and is reproduced with the permission of the Controller of His Majesty's Stationery Office.

The timbers other than teak imported were chiefly gurjun, pyinkado, rosewood, Indian silver-greywood and laurel. The increase was mainly under gurjun. For this the railway carriage and house flooring demands were responsible.

There were heavy direct re-exports of rosewood to the Continent towards the latter half of the year.

Apart from teak and rosewood there was no appreciable increase in prices. Competition for the limited market keeps the price of gurjun low.

Deliveries of timber through the agency of this officer were 1,241 tons in 1936-37 as against 1,053 tons in 1935-36.

Sales were effected for 2,430 tons in 1936-37 as against 1,006 tons in 1935-36. The increase was under gurjun and Indian silver-greywood. There was a slight increase in the demand for laurel, which was met by shipments through the usual trade channels in addition to those arranged through this office.

ENQUIRIES

Commercial enquiries of the year analyse as follows:

Enquiries resulting in sales ...	37
Enquiries for specified quantities of timber not resulting in sales ...	34
Tentative enquiries regarding supplies and production ...	10
	81

There were in addition the usual miscellaneous enquiries.

There was an enquiry for sissoo logs suitable for veneers: but apart from the fact that the Indian demand absorbs all the sissoo available the specification for logs for veneers is very high.

PROPAGANDA

The principal shippers of Burma teak again staged a very effective display of Burma teak at the British Industries Fair at Olympia, and teak was, as usual, conspicuous as garden furniture there. Amongst veneers shown were some beautiful examples of Indian laurel and silver-grey. Generally, however, timber, except in the form of furniture and fancy goods, was not much in evidence at the Exhibition.

Decorative timbers are used largely as veneers, and Indian timbers, silver-grey, laurel, kokko, Andaman padauk, rosewood and figured teak were fairly conspicuous as flush doors and panelling at the Building Exhibition at Olympic in September.

The Timber Development Association continues its good work in the interests of timber. Amongst other activities the Association financed a specially constructed railway carriage to tour the country and illustrate the uses and merits of wood.

The monthly periodical, *Wood*, continues to maintain its exceptionally high standard of production, and must have a considerable influence in educating the public on the possibilities and beauty of wood, past, present and prospective.

The new escalators at Moorgate Underground Station have been constructed as a permanent exhibit of Empire hardwoods. Some 30 different hardwoods have been used in the form of veneers, each labelled with its name. These include Indian laurel, Indian rosewood, Indian silver-greywood and teak, figured and plain. The escalators have aroused considerable interest, and the London Passenger Transport Board have decided to panel the next four sets of escalators with Empire Woods, other than teak, the principal and almost the only timber used hitherto. Indian laurel will be used for the escalators at the Post Office Station.

The Government of India donated silver-greywood for the panelling of one of the rooms in the new building of the Royal Empire Society and the new headquarters of the Overseas League. The panelling is in carefully selected veneers and the result is most effective.

NEW ROAD SOIL STABILIZER

BY H. H. SLAWSON.

Highway engineers are following closely the results from the use of a new road soil stabilizing agent which has been used extensively in Pacific north-west States and in two eastern States the past year.

The binding substance is a by-product of rayon manufacture in the Shelton, Wash., plant of a paper pulp concern. By condensing, neutralizing and chemically treating the lignin "likker" remaining from the rayon process, an effective low-cost binder for traffic-bound road surfaces has been produced.

It is supplied to the market in a concentrated solution containing 46 per cent solids. After dilution with an equal volume of water, it is applied to the roadbed with a pressure distributor. This has transformed earth roads into dustless, safe, attractive, smooth-riding surfaces. Applied in conformity with exact engineering specifications roadways can be produced comparable to macadamized highways at remarkably low cost.

Over $3\frac{1}{2}$ million gallons of the new road soil binder were applied on hundreds of miles of unpaved highways and city streets, and the dirt shoulders of paved roads in the States of Washington, Oregon, Idaho, New Jersey and Maryland, during the 1936 construction season.

Eighty years of experimentation were devoted to perfection of the new binder. Now the chemists are seeking to produce the material in power form which would simplify the transportation problem.—(*Highway Magazine,* reprinted in *Roads & Road Construction,* November 1st, 1937.)

CARRON VALLEY NATIONAL PARK

The Forestry Commission are purchasing from the Stirlingshire and Falkirk Water Board a large track of hill country in the Carron Valley for afforestation purposes.

The area of ground to be taken over extends to 6638.13 acres. It is part of the huge acreage of land acquired by the Water Board to enable them to proceed with a gigantic scheme for forming a reservoir by flooding the valley through the damming of the River Carron.

This water supply project, which was launched in October 1935, is estimated to cost £285,000. Already excellent progress has been made with the work of constructing the masonry and concrete dam across the eastern end of the Carron Valley, near the Carron Bridge Hotel. The new reservoir, when completed, will have a capacity of 4,000,000,000 gallons of water.

This immense quantity of water, if spread over Stirlingshire, an area of fully 450 square miles, would cover the county to a depth of about half an inch.

It is estimated that the work will be completed in about one year's time. Its completion will mean that another beautiful loch, an artificial one, three miles in length, will add to the attractions of one of the loveliest districts of Stirlingshire. The Forestry Commission, recognising that this would be an ideal region for the formation of a State forest, entered into negotiations with the Water Board, and have succeeded in securing large tracts of land on the banks of the future reservoir.

The land which has been acquired by the Commission consists of portions of six farms in the area. One farm, that of Slachristock, has already been vacated, and the Commission have begun to lay down plantations there. Kirk o' Muir Farm has also been taken over, and it is understood that planting operations will be set in motion there in the near future.

Open to the Public

The farms of Easter Gartcarn and Smallburn, which are still occupied by landlords and tenants, will be vacated at Martinmas, and at the same time a portion of the farm of Craigannet will be available to the Commission for afforestation. The farms of Binns and Finnich Haugh, which are also included in the scheme, are not to be vacated until November 1939.

The new Carron Valley forest, it is understood, will virtually become a national park. The afforestation scheme will be open to the public, on condition that visitors do not light fires, drop matches or cigarette ends, or do anything which may lead to an outbreak of fire. The privilege will be withdrawn if visitors damage the young trees by breaking off shoots.—(*Scotsman*.)

THE MAN-MADE DESERT IN AFRICA—EROSION AND DROUGHT

BY PROFESSOR E. P. STEBBING

What is Erosion?

And what is meant by Drought when the word is used in connection with the man-made desert in the making?

Articles in the press and even more scientific papers often leave one in doubt as to the exact nature of the calamity being described. The advance of the Sahara does not appear to have much in common with the Dust Bowls of the United States and Canada, or with the soil-drift in Southern Australia. It might also be held that the soil erosion taking place in parts of Kenya was quite a different thing from the desiccation experienced in Northern Nigeria.

Moreover, in connection with most of these occurrences the word "drought" is used. *Is this word correctly employed for a state of affairs brought about by the over-utilisation of the soil by human agency, the outcome being the man-made desert?*

It would appear, from the rather loose manner in which these two words, erosion and drought, have come to be used with reference to what may be termed the more modern instances of the mis-utilisation of the soil on the grand scale, that they require definition. For although the final resuit of destroying Nature's balance in any particular region is the same, the routes by which destruction proceeds vary; consequently the means adopted to combat the trouble will equally vary.

I have to plead guilty, though quite unconscious at the time, to a misunderstanding of the type here in question. I used as the title of an address given before the Geographical Society (*Geog. Journal,* Vol. 85, No. 6, 1935) "The Encroaching Sahara." Admittedly the expression is open to misinterpretation. But I was scarcely prepared to find later that by "Encroaching Sahara" I was supposed in certain quarters to have meant it to be understood that the desert was advancing over, or invading, the inhabited country to the south by a series of sand waves, like the advancing tide of a sea. Yet this proved to be actually the case.

Moreover you could find in Nigeria expressions as varied as "sand invasion," "sand penetration," "sand displacement," "sand drift," "desiccation," "erosion," "advancing Sahara," a confusion of terms to which widely different interpretations were given. And yet for that part of Africa situated to the south of the Western Sahara boundary the actual processes of desiccation, it can scarcely be accurately termed erosion *tout court*, are much the same for the whole region.

It would appear necessary, therefore, if we are to arrive at the means by which erosion in its various categories may be stayed and ameliorative conditions be introduced, to understand exactly the processes by which the particular form of erosion is taking place.

This paper is mainly concerned with Africa but allusions will be made to India, the Dust Bowls of the United States and Canada, and the soil drift and deserts in the making in Southern Australia.

All commentators on soil erosion in Africa are in agreement that the continuance of the present methods of agriculture in many parts of the country is intensifying land hunger, land sterility and decrease in water supplies. It would be of interest to know, if such a figure were available, the total area of this Continent suffering at the present day from the dangers of erosion in its various forms.

The following are types of erosion: 1. Sheet Erosion; 2. Soil Erosion due to over-cultivation; 3. Soil Erosion due to excess pasturing; 4. Soil Deterioration; 5. Sand Invasion or Penetration; 6. Desiccation; 7. Soil Denudation and Gully Erosion.

1. Sheet Erosion

Resulting from the cultivation of the soil on slopes without any protective works such as are afforded by some form of terracing. Results in the washing away of fine clay (or other) particles in suspension by water leading to gradual change of a rich loam (or other) soil, rich in plant food with a layer of decaying vegetation (humus) above it, into a poor soil devoid of humus, unable to retain water, which gradually becomes incapable of supporting vegetation. This type of erosion is common in Africa since much of the cultivated land in some parts is on the sides of hills with a slope equal to or greater than 8 per cent., the latter being considered to be the maximum for unterraced land. A considerable amount of investigation work has been carried out in America and Russia on the subject of the degree of slope which can be safely cultivated without terracing. For

practical purposes an examination of the local rock and of gullies and so forth cut in the hillsides, or cuttings in the banks of streams, will provide considerable information as to the desirability or necessity of terracing slopes which are to be put under, or are already under, cultivation. The people of some countries have realised this apparently for themselves. On the slopes of the Himalaya (both Eastern and Western regions) cultivated areas are terraced. The Japanese are also exponents of terracing. The African method of cultivation on a hillside without any form of terracing is suicidal, since under it the rich soil particles are gradually washed away, the soil grows poorer and poorer until it finally becomes useless for crops. It may then be made over to the pasturage of stock with the inevitable end that the area becomes a barren hillside. During this form of utilisation of the hill soils previously covered by a protective forest, or a grassy covering with matted roots, much valuable soil is washed away during the wet season, being carried into the streams and rivers, often in the form of floods, and dissipated for ever.

Under Sheet Erosion the upper rich particles of soil are in the early stages washed into the streams under heavy rainfall, discolouring their waters and finally reaching the rivers of which the streams are tributaries. The erosion at this stage may be slow and almost imperceptible. With continued and perhaps enhanced cultivation the soil displacement takes place at a greater rate, the streams during rainfall become turgid torrents and larger amounts of the valuable parts of the upper soil and sub-soil layers are carried down and lost in the rivers of the level country. At this period wind is also assisting in the dispersal of the now finely reduced soil particles.

In Ashanti, Gold Coast, the countryside is crossed by two great scarps to the north of town of Kumasi, the southernmost curving southwards to the east of the town and continuing further south. This southernmost scarp is met at the twenty-sixth mile from Kumasi on the road north to Kintampo. Up to the scarp and on it in parts, cocoa plantations are mostly to be seen. I was told that most of this scarp where erosion had commenced in places was under plantations or farms. This and the destruction of so much of the forest in the environs of Kumasi were doubtless the cause of the failure of the Kumasi water supplies which were dependent upon wells. A large sum has been spent on the construction of a magnificent reservoir.

Since the wells have failed and the scarp is being heavily cultivated under methods which lead to erosion it may be asked for how long can this reservoir depend upon a constant water supply—unless a certain percentage of the scarp is maintained under forest?

This type of erosion is very common in Africa. Mr. A. S. Champion's description of the erosion taking place in the province of Turkana in Kenya Colony (*Georg. Jour.*, with illustrations, February, 1937) is in parts typical of this type.

2. Soil Erosion due to Over-cultivation

This form of erosion is in its action very similar to Sheet Erosion, but it is confined to more or less level plains country. The top soil from repeated cultivation coupled with exposure to a hot sun and strong, probably hot, winds disintegrates *sur place* and assumes the form of dust which is blown away in clouds. It is probable, from the modern examples now in process of formation, that this is one of the methods, if not the principal method, by which the more level portions of some of the large deserts of the Globe were brought into being, probably with the assistance of excessive pasturage by stock. With the dispersal of the top soil the area loses its fresh fertility; subsequent continued cropping of the soil leading to increasing impoverishment of the soil layers capable of production, the drying up of water supplies and lowering of the water table, decrease in rainfall. with the final formation of a desert.

Modern day notable examples in process of formation:

In the United States some 900,000,000 acres of land in the North-Central and North-Western States as well as in parts of the South. have been affected in this way by the over-utilisation of the soil in the production of wheat and cotton, in what is known as the Dust Bowl. This has not only impoverished large numbers of farms but still threatens to engulf a larger area of the fertile country in the immediate vicinity of the outer periphery of the Dust Bowl. The recent (1937) great floods in the Mississippi may in part have been assisted by the run off from the ruined prairie lands to the west of the river, turned into a desert bowl by over-cropping.

Canada, in the prairie provinces of Saskatchewan and Alberta, has the same story to tell. Sir Evelyn Wrench during a recent journey to the region says, "It was difficult to realise that these endless

miles of burnt-up plains were the same prairies where I had seen 25 years ago, wheat waving breast high as far as the eye could reach."

He continues, the warning had been given that Southern Saskatchewan was only suitable for stock-raising and not for grain-farming. The warning was correct, "as the burnt-up 'dust bowl' to-day of an area some 400 miles wide and 300 miles deep testifies." A long series of bad years began in 1929. In 1928 Saskatchewan produced 321,215,000 bushels of wheat. In 1937 the output was estimated at 75,000,000. Early rains came in the spring foreshadowing a bumper harvest. But the rainfall is now unstable. No further rainfall occurred, and the hot winds of early summer killed a large proportion of the crop.

These two instances are grave examples of the pace at which, under modern conditions, the processes of erosion can proceed. For in olden times erosion of this type probably took centuries before it made a serious impression on the countryside.

In Africa much of the desert-forming country round Gao, in the French Sudan Colony, and away to the north towards Tabankort and westwards into the present Mauretanian desert (all in the Western Sahara), a highly-populated area a few centuries ago, must have started on the downward grade by over-cultivation combined with firing the countryside.

Another type of soil degradation under repeated farming results in the gradual replacement of all tree growth by tall grass, which degenerates into a rough type of tussocky grass covering a ruined soil useless for agricultural purposes and often waterlogged. Good examples are to be seen at Tabe in Sierra Leone, where both types are now under experimental artificial afforestation by the Forest Department. These areas were once under high forest, and over-cultivation has brought them to this ultimate degradation. Examples of both types could be multiplied in this Colony; and, of the first, in parts at least of the Gold Coast, as *e.g.*, in the extensive areas with a few widely scattered trees of the old forest still standing in the neighbourhood of Faomang in Ashanti.

3. Soil Erosion due to Excess Pasturing

Due to excessive browsing and pasturing, combined with trampling, which in the initial stages may reduce the soil to a hard consistency. With the excessive removal of the grass by grazing or pastur-

ing, the soil suffers by becoming impoverished through the loss of phosphorus, nitrogen and potash, whilst the trampling results in insufficient aeration of the humus layer which would continue to be formed. When an excess number of animals is maintained on an area, the land is gradually eaten bare and the consequent exposure and trampling, under the conditions of heat and rain, results in the top soil being eventually reduced to dust, when it is blown or washed away. Once this condition has been set up in more or less level plains country, the ultimate result (longer in the case of forest-covered country than in the case of grass-covered) is the destruction of all vegetative covering and the production of a desert; or in the language of America, a "Dust Bowl." The last stage may be the appearance of the bare rock on the surface.

It is not necessary to go out of Europe to see examples of this type of erosion. It is a stock phrase known to many that the soils of the Greece of old were destroyed by goats. Parts of Africa are following the same road. Those of us who were in Macedonia during the War, especially those who had previously studied this erosion question, had plenty of experience of what the goat has left behind him—hillsides of bare rock with small plateaux in which stones were more plentiful than soil—a stern, grim country from which to try and wrest a living, or even to try and fight in. I heard though, whilst there, that the goat in this instance was not solely to blame. That a Turkish Government in the past, wishing to raise some revenue, had put a tax on trees on private estates. The proprietors quickly released themselves from the power to pay by felling all the trees owned by them!

For a long period the state of affairs resulting from over-grazing has been known in India and more especially to the Forest officer, the animals in question being the buffalo, cattle, sheep and goats (omitting the camel and the elephant). Examples of damage and loss can be shown all over India. Large areas of plains forest of a poor degraded type not under the Forest Department can show evidence that their present condition has been brought about by excess grazing and fire.

In the drier parts of India this condition of affairs is very apparent, especially over considerable areas of some of the Indian States in Central India.

For Africa as a whole this danger and damage exists on an increasingly aggravated scale. Recent reports and correspondence in

this matter of Sir Daniel Hall, Mrs. Huxley, and Sir Frank Stockdale and others, all deal with this problem.

A typical example of erosion of the type is alluded to by the two former in the case of the Wakamba reserve in Kenya. Sir D. Hall traversed miles of this reserve in 1929, and described parts of it as "bared down to hard pan—purple, red and yellow, which had been grazing ground within the memory of chiefs." In 1937 Mrs. Huxley, in alluding to this area, said that "the cattle population was estimated at 250,000, and the present capacity of the land on which they exist has been put at 20,000. The result is that the pastures have been trampled and over-grazed to such an extent that grass has been killed, bare land exposed to the elements, and erosion in its acutest and most rapid form has set in." To how many forest officers, on reading these words, must eye pictures of a similar type of affairs seen on more than one occasion during their service have arisen in the mind!

In America some 60,000,000 acres of land in the Pacific North-West has been so over-grazed that it can now only carry one-fifth of the previous head of stock. Whilst in South Australia, millions of acres of a countryside which a decade ago carried sheep are now desert.

4. Soil Deterioration

This type of erosion is typical of its kind. It results from clear felling of areas of virgin tropical forest, *e.g.*, rain forest in West Africa, and exposing the soil which had always been protected by the dense overhead canopy of the trees, with the consequent drying up of the moisture in the humus layer (nowhere of great thickness) and lowering of the water table. This is not erosion in its strict sense at this stage, although it leads to it.

The commonest example on the large scale has been the replacement of the forest by man with crops such as cocoa, coffee, tea, rubber, and so forth. The new vegetable cover is no longer adequate to protect the moisture values and the humus layer so long maintained by the dense canopy of the forest. Moreover, the new crops are more exacting in their demands on the soil. Moisture values change, soil deterioration sets in, and a gradual impoverishment of the area takes place.

This type of deterioration, often accompanied by subsequent erosion, is no new thing, unfortunately, in our Empire. Ceylon can

show many classic examples, the aftermath of the times (in the early parts of last century) when the island was an el dorado for the Planting Community and a successful colony financially from the Government viewpoint. But success of this kind is ephemeral. Neighbouring Madras was also enjoying prosperity of the same type. The position which has been reached in parts of this Presidency is shown by the graphic description of the methods of the coffee planters given by Colonel Beddome, the Conservator of Forests, in a report dated November 3rd, 1876. He wrote: "The planters who come over from Ceylon are now giving a very high price for land, and the whole mischief may be effected in a very short time. It must not be supposed that coffee is at all a permanent cultivation: we have only to look at the Sampajee ghat in Coorg, the Carcoor ghat and many other places in the Wynaad, . . . to see at once that it is very often very little better than the shifting cultivation of the hillmen. The list of deserted estates is, I fancy, much greater than that of estates kept up, and if it had not been that the price of coffee suddenly doubled itself a few years ago, there would be hardly any of the old estates kept up at all, at least in North Wynaad and Coorg. It pays a coffee planter to take up a tract of primeval moist forest on our mountain slopes for a few years; he gets bumper crops the third, fourth, and fifth years, but denudation of the soil goes on rapidly, and it does not pay him to keep it up many years. Can we restore the grand old forest with all its climatic influences? A thorny wilderness takes its place." This was written over sixty years ago. Yet some of us could write the same pen picture of areas we know to-day.

I had this type of economic development in mind whilst seeing something of the wonderful progress being made by the French in that very rich colony, the Ivory Coast. Planters, French and Native, were being encouraged to "open up" the rain forest by forming plantations of cocoa, coffee, rubber, bananas, and so forth on an extensive scale. I had the opportunity of discussing this matter on several occasions with the Governor. The opinion was apparently strongly held that the rich old forest soil, the product of many centuries and always protected by the dense overhead canopy, would continue indefinitely to yield abundant crops and large returns in cash. Since cocoa was an article of which there was a great consumption in France, its planting on a large scale was advocated. From the economic policy point of

view on the face of it the advice was sound. But for how long will this rich soil stand the exposure?

A striking illustration of this type of soil deterioration is to be seen in the present position of some of the cocoa-producing areas in the Gold Coast (situated next door, to the east, of the Ivory Coast). Will there be any succession to the existing trees? I remember being told that about 26 years was the probable financially productive life of the tree. At the end of this period is the soil worn out? If so, has the next step received consideration? And what is it to be?

5. Sand Invasion or Penetration

Sand penetrating from a desert due to the maltreatment of the vegetative covering of neighbouring lands and the consequent deterioration in the soil values for either crop production or stock pasturing. The final degradation is not entirely due to erosion in the commonly accepted understanding of the word. Or sand blown back from silted-up river banks or the shores of lakes (as *e.g.* in the case of Lake Rudolph, as mentioned by Champion *loc. cit.*); or invading sand blown inland from the sea coast.

This desert invading sand in West Africa has been variously termed sand invasion, sand displacement, sand penetration, sand drift, and sand encroachment; and by myself and others, encroaching Sahara and advancing Sahara.

In West Africa the process owes its commencement to the system of farming the bush or degraded type of forest which covers much of the countryside, this system being a form of shifting cultivation. With an increasing population the same areas are refarmed at shorter intervals, with a consequent more rapid deterioration of the soil constituents, until a stage is reached when the soil is no longer sufficiently productive for agriculture.

It may then be made over for stock-raising. The grazing and browsing, accompanied by the universal practice of annually firing the countryside, reduces the quality, height and density and therefore of the resisting power to sand penetration of the now much-degraded forest or bush, and the soil becomes covered with a sandy top, gradually increasing in depth. Once this stage has developed the rapidity in the degradation of the bush increases until it no longer affords sustenance to cattle; then the sheep disappear; and under the

final exploitation by goat herds to feed their flocks the savannah succumbs and the desert has encroached and extended its boundaries.

When the agriculture has gone, before which period sand penetration has already commenced, and the reign of the stock, cattle, sheep and goats, is at its zenith, it is still not too late for protective and remedial measures to be introduced in order to stay the sand penetration.—(*Extracted from Supplement to the "Journal of the Royal African Society," January* 1938, *Vol. XXXVII, No. CXLVI.*)

(*To be continued.*)

DOMESTIC OCCURRENCES

Death

Hodge.—At St. Michael's Hospital, Hayle Cornwall, on the 15th April 1938, Dorothy, the wife of Mr. W. E. Hodge, I. F. S.

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for February 1938:

IMPORTS

ARTICLES	MONTH OF FEBRUARY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
Siam ..	..	50	226	..	4,627	27,811
Burma ..	..	..	10,591	..	..	13,85,650
French Indo-China	..	292	151	..	35,124	21,935
Other countries ..	5	..	295	390	..	35,270
Total ..	5	342	11,263	390	39,751	14,70,666
Other than Teak—						
Softwoods ..	1,858	389	1,141	1,02,545	20,013	87,557
Matchwoods ..	..	806	413	..	41,280	20,668
Unspecified (value)	..	..	..	1,76,574	21,131	2,74,589
Firewood ..	15	..	70	225	..	1,053
Sandalwood ..	19	19	23	4,263	6,789	3,443
Total value ..	..	..	..	..	..	..
Total value of Wood and Timber ..	..	..	..	2,83,997	1,28,964	18,57,936
Manufactures of Wood and Timber—						
Furniture and cabinetware ..		No data			No data	
Sleepers of wood ..	..	..	..	..	..	..
Plywood ..	..	538	248	..	83,193	62,069
Other manufactures of Wood (value) ..	..	..	..	2,16,334	95,661	1,25,076
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,16,334	1,78,854	1,87,145
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	28,538	3,434	14,059	1,88,731	28,839	1,23,261

EXPORTS

ARTICLES	MONTH OF FEBRUARY					
	Quantity (Cubic Tons)			Value (Rupees)		
	1936	1937	1938	1936	1937	1938
Wood and Timber						
Teakwood—						
To United Kingdom	4,114	3,891	22	7,94,908	8,34,392	2,781
,, Germany ..	407	182	..	88,816	48,458	..
,, Iraq ..	16	246	66	4,134	36,544	12,117
,, Ceylon ..	278	257	..	35,978	39,454	..
,, Union of South Africa ..	220	627	..	47,479	1,40,740	..
,, Portuguese East Africa ..	321	196	..	48,195	35,567	..
,, United States of America ..	29	4	..	5,982	1,092	..
,, Other countries	261	546	189	52,421	1,19,375	25,497
Total ..	5,645	5,949	277	10,77,913	12,55,622	40,395
Teak keys (tons) ..	471	267	..	73,547	38,510	..
Hardwoods other than teak ..	58	216	..	5,987	20,145	..
Unspecified (value)	..	..	..	26,272	1,80,602	44,380
Firewood ..	8	1	..	40	31	..
Total value ..	..	..	..	1,05,846	2,39,288	44,380
Sandalwood—						
To United Kingdom	..	1	5	..	1,500	6,000
,, Japan ..	20	7	..	21,200	7,400	..
,, United States of America ..	50	115	50	50,000	1,18,000	50,000
,, Other countries	16	7	20	19,058	5,132	19,186
Total ..	86	130	75	90,258	1,32,032	75,186
Total value of Wood and Timber ..	..	..	..	12,74,017	16,26,942	1,59,961
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	12,323	24,788	31,809
Other Products of Wood and Timber		No data			No data	

INDIAN FORESTER

JUNE, 1938.

SOIL LOSSES FROM INDIAN FOREST GRASSLANDS AND FARMS

BY R. MACLAGAN GORRIE, D.SC., I.F.S.

Reliable run-off figures for forest and grassland are now available for the first time for Indian conditions. A technique of volumetric analysis of water and silt was worked out by the Punjab Irrigation Research Institute Staff at Madhopur in 1936 for a type of small isolated square of undisturbed soil $3\frac{1}{2}$ square feet in area. This method was described in the *Indian Forester* of December 1937, pp. 839—846, and has been followed in forest plots at Nurpur in the Kangra district. A battery of six plots gave three pairs of grass, grass and shrubs, and bare soil on a slope of 1 in 4 on an eroded hillside of poor Siwalik sandstone. The grass cover over all is distinctly poor, as it is recovering slowly from previous heavy grazing. The bare plots contained a little grass which has been kept clipped back with scissors. They thus simulate local grazing conditions to some extent, though we have not reproduced the destructive trampling action of cattle scrambling about on a greasy hillside; and the run-off from grazed areas must therefore be considerably heavier than the figures now reported. The results of the first monsoon's catch are as follows:

	Grass 80% cover.	Grass and shrubs 90% cover.	Bare soil; grass clipped every 3 days.
	Per cent.	Per cent.	Per cent.
Percentage of rain which ran-off—			
Out of a total of 46″ on 32 wet days during July—October, 1937	7	5	25
Out of a total of $5\frac{1}{4}$″ in four hours. The heaviest single storm	2.2	1.7	6
Weight of soil lost per acre—	lbs.	lbs.	lbs.
Carried away on 32 wet days	3,500	3,900	18,500
Carried away by a single storm $5\frac{1}{4}$″	260	307	3,511

These figures give one food for thought when it is realised that in a single storm the uncovered plots lost soil at the rate of 1½ tons per acre. This may be taken as a typical figure for all bare fallow fields in the foot-hills, except properly levelled rice land, and they are definitely conservative for the average village grazing lands which suffer from trampling of cattle. The ordinary grazing lands also suffer from the accumulative action of shallow gullies cutting the surface on long slopes, a phase of erosion which is of course not reproduced in our small square plots.

Many people have thought that the enormously heavy soil losses quoted from American measurements for ploughed fields are exaggerated and not applicable to Indian conditions. Measurements reported from the Bombay Dry Farming Research Station at Sholapur (chief investigator, Mr. N. V. Kanitkar) show a loss of 115 tons of soil per acre per annum from a field of *jowar* which is the most important combined grain and fodder crop in the Bombay Deccan. This loss was caused in a properly cultivated plot as the result of two very intense storms of 3.5 inches and 4.3 inches. The total rainfall of 28 inches is usually fairly well distributed and no such intense storms occurred during the previous year when measurements were started. The silt lost in these intense storms was particularly rich in valuable plant foods such as lime and potash, which were stolen by erosion, leaving the remaining soil much poorer. Of the various other kinds of plant cover tested, the amount of water lost in run-off was not strikingly different where weed or crop cover was dense. The amount of soil lost where the weeds had been preserved in fallow was just one two-hundredths of the *jowar* plot, while the clean fallow of bare but uncultivated ground yielded 25 tons of soil per acre or 22 per cent of the *jowar* plot's loss. These astonishingly heavy losses of silt were from very gently sloping ground, the average slope being 1¼ per cent or 1 in 80, and the data are entirely reliable having been collected from thoroughly isolated plots.

A further point which this experiment has brought out is that good cultivation on a slight slope is no better than bad cultivation for saving soil unless it is protected by some form of bunding. The only sure way of reducing soil losses during exceptionally heavy storms is by contour ridging which is sufficiently deep to render each field a more or less self-contained catchment unit, so that cumulative run-

off from a series of fields is prevented. The necessity for such protection is brought out by subsequent figures for these same plots in 1937, so far unpublished but furnished in a letter from Mr. N. V. Kanitkar, who reports that this same *jowar* plot has lost a total in the year of 133 tons per acre. This included one storm in which 2.13″ of rain in half an hour removed the huge amount of 52 tons of silt per acre. I am indebted to Mr. Kanitkar for permission to use these unpublished figures, but a fuller description of his experiments from his own pen would be of great interest to *Indian Forester* readers.

A NOTE ON SOIL CONSERVATION WORK IN AMERICA

BY J. N. SINHA, BIHAR FOREST SERVICE

Abstract.—Washing-off of the fertile soil through erosion has gone on in America for a long time. Good agricultural land has been rendered marginally productive or unfertile, entailing great national loss. To combat this a Soil Conservation Service has been started. Its operation costs the Federal Government five crores of rupees annually. Much amelioration has been achieved already. A similar problem exists in most parts of India.

Introduction.—I travelled from England to India *via* America and took the opportunity of studying the soil conservation scheme of the United States. America has fully realised the terrible effects of soil wash-off and the consequent impoverishment of agricultural land. Farms that used to yield rich and ample crops have now been reduced to a sub-marginal state of productivity. Many farms once prosperous have been abandoned. The reason is that the top soil has in course of time been washed away and it is the top soil alone that grows crop. The productive soil is always only a few inches deep. Erosion and soil wash-off takes place in two principal forms: (1) "Sheet erosion" and (2) "Gully erosion." The latter is at once noticeable but "Sheet erosion" escapes detection until the effects are felt on the crop yield. It is this "Sheet erosion" that is the subject of major concern in America.

The following centres of activity were visited:

(1) Duke Forest at Durham, North Carolina.

(2) Soil Conservation Service at High Point, N. C.

(3) Erosion Control Experiment Station at Statesville, N. C.

(4) Appalachian Forest Experiment Station at Asheville, N. C.

(5) Tennessee Valley Authority at Norris, Tenn.

The Soil Conservation Service.—As evidence of realisation of the seriousness of the problem of soil wash-off, a Soil Conservation Service was inaugurated in 1933. This is a branch of the United States Department of Agriculture. The Federal Forest Service is also a branch of the Department of Agriculture. The Soil Conservation Service (hereinafter referred to as S. C. S.) began its operations in the spring of 1934 and has since been doing excellent work. It costs about 20 to 25 million dollars per year to the Federal Government (equivalent to $5\frac{1}{2}$ to $6\frac{3}{4}$ crores of rupees). Of course there is little or no revenue. But this expenditure is considered imperative if farmlands in the United States are to be saved from running into waste land.

With its headquarters in Washington D. C. the S. C. S. operates in all States but the intensity of its activities is naturally dependent upon the actual and varying needs. For instance, the southern States of the U. S. A. are in need of greater attention than the rest. Farming in the past has been careless and destructive resulting in 50 per cent of the top soil (ranging between 25 and 75 per cent) having been washed away. The principal crops in the southern States are tobacco, cotton and maize, all of which being clean-cultivated crops and affording little protection to the soil from the denuding force of running water are particularly destructive to the land.

Structure of the S. C. S.—The S. C. S. is subdivided into divisions whose boundaries in practice coincide with those of the States though this is not necessary. Divisions in turn are subdivided into Projects. Each Project deals with one water shed. North Carolina State, for example, has eight Projects. The High Point Project covers an area of 140,000 acres or 200 square miles comprising 2,000 farms.

Topography and soil.—The topography of the State of North Carolina resembles that of the Chota Nagpur plateau. The land is gently undulating; in parts hilly. The soil is composed of red friable sandy alluvium with igneous intrusions. It is very erodable.

Forest cover is best for erosion control.—After a series of experiments (still in progress) the S. C. S. has discovered that where forest cover is still existing the problem of soil erosion is non-existent or negligible. If any part of the "problem" area can be put back to forest there is nothing else to be done. But as the bulk of farmlands has to be preserved for the growing of agricultural crops other methods of cure have to be found. Experiments have shown that the simplest

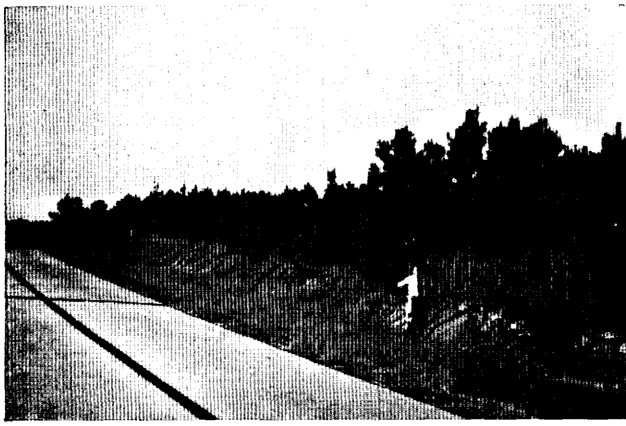
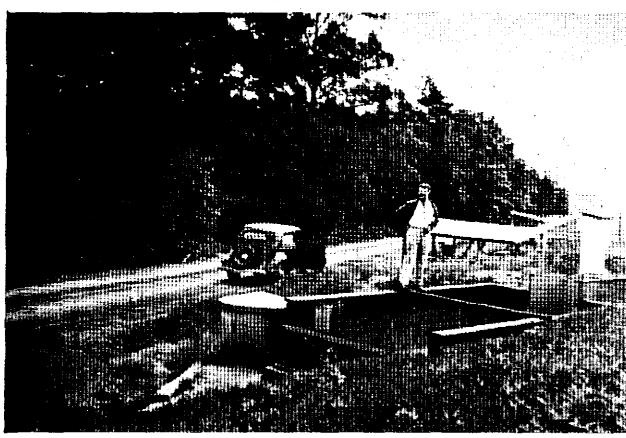


Fig. 1.—In the Duke Forest, Durham, N.C. The entire strip of pine was planted at the same time. The unequal height growth is explained by Prof. Maughan (in the picture) as due to top soil having been washed from above and accumulated at the bottom side.

Fig. 2.—A simple method of reclaiming gully erosion. Locust (*Robinia pseudacacia*) sown in the gully. It grows fast and stabilises the bottom. The sides gradually build up.

Left—
Fig. 3.—Water-stage Recorder.

(*Photos by J. N. Sinha*).



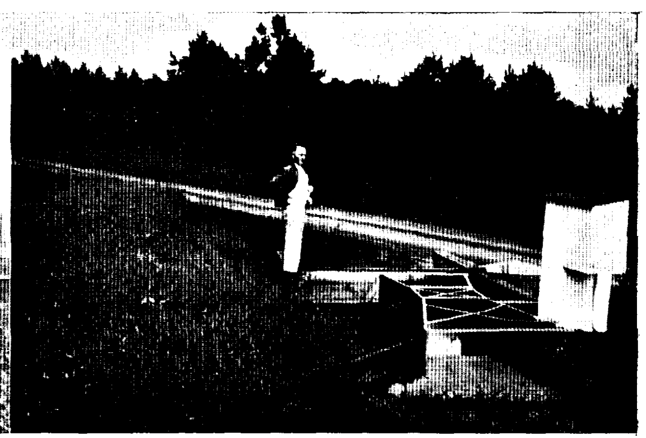


Fig. 5.—Ramser Silt Sampler.

Fig 4.—Parshall Flume.

Device for measuring rain run-off and soil erosion.
The rain run-off from a demarcated area is led into Parshall Flume. The water stage recorder is a clock-work device which automatically records the height of water flowing at any stage into the Parshall Flume. From this the total quantity of water that ran into the Parshall Flume within any given period can be calculated. Installing a clock-work rainfall recorder at the spot it can be calculated:—

(*a*) How much rain fell. (*b*) How much of it ran off.

In the Ramser Silt Sampler the soil washed away is collected and measured. This yields a third item of information:—

(*c*) How much soil has been washed away.

Repeating this experiment under different conditions of slope, soil vegetation, etc., comparisons can be made.

method of erosion control is the rotation of crops; for example, for one year of the clean-cultivated crops like tobacco or cotton or maize the land should be put for the following three years to grass or other leguminous fodder. From the point of erosion-resisting qualities the following gradation of crops has been evolved:

(1) Bermuda grass (*Cynodon dactylon*), common *doob*.
(2) Lespedeza grass (*L. serecia, L. striata, L. stipulata*).
(3) Clovers (*Trifolium* spp.) } leguminous fodder.
(4) Cow peas (*Vignia sinensis*) }
(5) Alfalfa grass (*Medicago satreva*).

Strip-cropping.--On more sloping land where it cannot with safety be put to the clean-cultivated crop even for one year strip-cropping is practised. It consists in growing cotton or tobacco in strips at right angles to the slope (that is, along contours) alternating with one of the preventive crops.

Terracing essential on steep slopes.—On steeper slopes terracing is carried out so that rain water may not rush down rapidly and erode the soil. A vertical spacing of 3 to 6½ feet for terraces is considered suitable. The water thus arrested seeps into the subsoil and is made available for plant growth. On land whose productive capacity is too depleted by the washing away of top soil manure is put in quantities as may be necessary. When the S. C. S. started its operations in 1934, there was little realisation among the masses of the critical state of the farmland and little sentiment therefore in favour of the S. C. S. scheme. All that was advisable or practicable was persuasion by demonstration. The S. C. S. would do the necessary work on representative types of farmland all at the Federal Government's cost. Of course the work done benefited the farmer immediately, but the S. C. S. achieved its purpose by bringing home to him and others that something had to be done to save the farmland from utter ruination and what the practical methods were. The methods employed by the S. C. S. on privately-owned farmlands were terracing of steep slopes, rotating the crops, supplying seeds and sometimes manure free of cost, arresting gully erosion by suitable methods of bunding and planting, relegating the unredeemable farmland to forest-growing, etc. All this cost a great deal of money, but the results were not far to come. When I visited the areas in September last I found that the peasantry had so far been educated in such a short time that on their own lands they were now carrying out all

the work as advised by the S. C. S. The S. C. S. has now cut down almost all direct financial assistance which had to be given initially. The S. C. S. has now merely to supervise the farmlands and tender advice and in certain cases help with seeds, etc.

A thorough survey of all the land in a given Project is the starting point. All land is classified according to topography, erodability of soil, use to which it has been put in the past and how it is being used at present. A rough scheme is then worked out as to how best to use the land so as to prevent further deterioration. The individual farmer concerned is then approached and in collaboration with him a detailed scheme of crop rotation, terracing, etc., is worked out for his land. The scheme ordinarily lays down the speediest means of recuperation but in certain cases the condition of land may require cessation of the money crop (like cotton, tobacco, etc.), but when the farmer, which is sometimes the case, is dependent for his livelihood on that land alone compromise has to be made. An agreement is drawn up with the farmer whereby he binds himself to carry out all the instructions given by the S. C. S. in regard to the farming methods and in return the S. C. S. lends him free of cost the advice and supervision of its staff, financial aid at times and all the latest information available from the experiments carried out elsewhere. The scheme works smoothly as the farmer's point of view is taken fully into consideration and he realises that it is for his good. The results are encouraging.

Work done at High Point.—At High Point N. C., I was shown round by the S. C. S. officials. This is one of the typical "problem" areas and the farmers have been persuaded to enter into agreement such as is described above. Comparing it with similar land elsewhere the effects of work done by the S. C. S. can at once be appreciated. The land is showing marked stabilisation and improvement. The S. C. S. officials have faith in their methods and are keen.

Experiments at Statesville.—At Statesville the S. C. S. has established an Erosion Control Experiment Station. Here experiments are conducted on all phases of soil erosion. One of the experiments measures the amount of rain-water that runs off and the quantity of soil that is consequently washed away on a given land (1) when it is bare, (2) when put to cotton, maize or tobacco, (3) sown with grass or leguminous fodders of several kinds, (4) when it is terraced, and

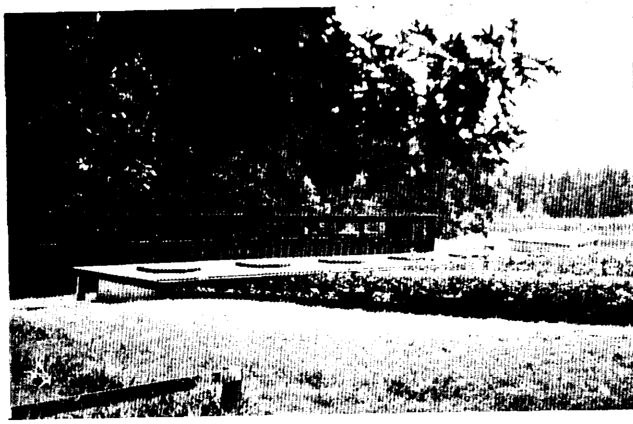


Fig. 6.—Small scale experiment to determine run-off of water under different vegetations. The rainfall is measured and the escaping water is collected and measured.

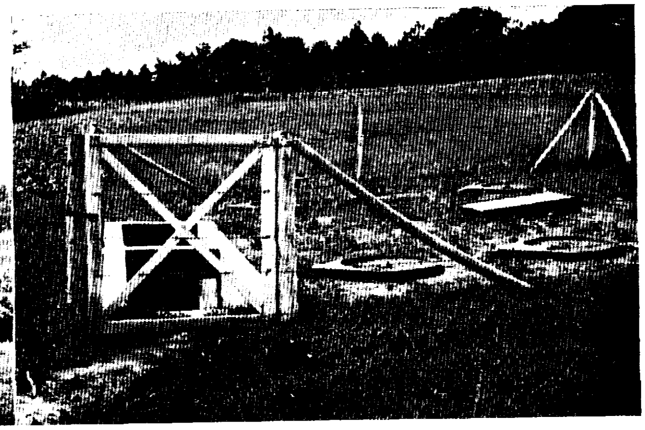
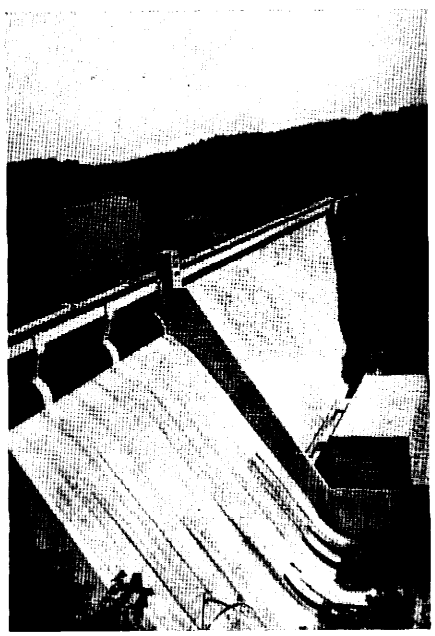


Fig. 7.—Experiment to determine what proportion of rain water soaks into the soil under different vegetations. In the circular trays different crops are sown and the water that has entered the soil is collected down and measured.



Left—
Fig. 9.—Norris Dam, one of the 7 dams built by the Tennessee Valley Authority in the Tennessee River. This one in the Clinch River, a tributary of Tennessee River, Length 1872 feet, Height 265 feet, works two 55,000 H. P. generators. Cost 15 million dollars (Rs. 3½ crore).

(*Photos by J. N. Sinha*).

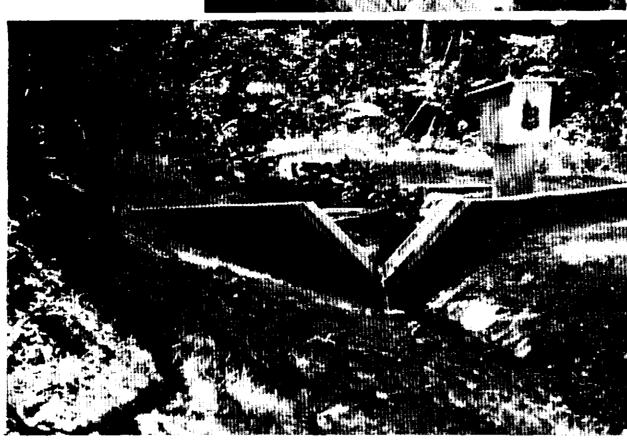


Fig. 8.—A simple device installed in forest to measure run-off of rain water from one catchment area. The wooden case on right contains a clockwork recorder of level. The V-notch is calibrated so that knowing how the water level immediately behind the V-notch has changed, the total quantity of water that has escaped within a given period can be calculated. This instrument may be obtained from Messrs. Julian P. Friez, Instruments, Baltimore, Maryland, U.S.A.

Fig. 10.—Gully reclamation. Simple wooden dams and mulching (i.e., spreading leaf litter) on the slopes helps appreciably to retard erosion.

(5) when crop is rotated. The experiment is repeated on soils of different erodability and on various slopes. By this means it can be ascertained to what extent the farmlands as now used are deteriorating through soil wash-off and escape of rain water which, if retained, would make a vital difference; also the effects of the various measures advocated by the S. C. S.

The Tennessee Valley Authority.—The Tennessee Valley Authority have their working centre at Norris, Tenn. This Authority was set up in May 1933 for the comprehensive development of an entire watershed comprising 40,600 square miles in the Tennessee Basin. The flood damage wrought by the Tennessee and Ohio rivers is well known. It is to combat this danger that the Tennessee Valley Authority was instituted. It has built nine vast masonry dams in 650 miles of the Tennessee river and its important tributaries. Their purpose is to check the downward rush of excessive rainfall and thereby reduce flood hazard; during dry months the water stored in these reservoirs is released to help navigation. Water falling from the dam creates power which generates cheap electricity. The electric power runs the Tennessee Valley Authority machinery and is sold to counties, municipalities and individuals for general electrification of the countryside.

But the prevention of floods cannot be effected by merely erecting massive concrete barriers. The disease is far beyond. Eroded hill-sides in the catchment areas must be restored to their original stability, otherwise the seasonal rush of water will continue increasing and the vast quantity of silt by settling behind the dams will in course of time defeat their object. The Tennessee Valley Authority is fully conscious of this fact and has taken vigorous measures for erosion control and afforestation on the lines described above.

Conclusions and suggestions.—It is apparent that generally in Bihar, as in several other parts of India, and particularly on the Chota Nagpur plateau, a similar problem exists. It is apparent too that something should be done. I suggest that the American method suitably modified to answer local conditions will be found effective; it will serve both to control floods in the rivers which receive water from the Chota Nagpur plateau and to help the agriculturist by increasing the productivity of his land. The need for pasture is pressing. Cattle in Chota Nagpur are such poor specimen. They are turned into

the forest and all is thought to be well. But forests do not always provide good grazing. Much of the unproductive or marginally productive lands can be converted into good pasture lands.

It is neither possible nor necessary to suggest a detailed scheme at this stage. I have not studied farming practices or the lands outside forests sufficiently enough to attempt the formulation of a specific plan. But the first requisite obviously is an appreciation of the condition of things. Once this is achieved the rest will follow.

Ten figures forming Plates 26-27 illustrate this note.

Acknowledgments.— I must take this opportunity of expressing my grateful and sincere thanks to the following officers for their most courteous help in making my tours in the United States of America both instructive and enjoyable:

(1) Dr. C. F. Korstian, Prof. W. Maughan and Prof. T. S. Coile of the Duke University, Durham, N. C.

I am indebted to Prof. Maughan for his kindly arranging my itinerary and putting me in touch with the other officers.

(2) Mr. C. H. Flory, Mr. R. B. Heberling and Mr. C. C. Abernathy of the Soil Conservation Service, High Point, N. C.

(3) Mr. F. O. Bartel of the Erosion Control Experiment Station, Statesville, N. C.

(4) Dr. R. M. Nelson of the Appalachian Forest Experiment Station, Asheville, N. C.

(5) Mr. E. C. M. Richards, Mr. George S. Perry and other officers of the Tennessee Valley Authority, Norris, Tenn.

My thanks are also due to Mr. J. N. Oliphant, Director of the Imperial Forestry Institute, Oxford, for kindly initiating the arrangements.

LATEST DEVELOPMENTS IN THE UTILIZATION OF TIMBER IN INDIA AND ABROAD

By S. Kamesam, M.I.E. (Ind.)

Timber Development Officer, Forest Research Institute, Dehra Dun.

Summary.—The five principal fields of modern timber utilization are—

firstly, as a structural material that can be employed practically for every kind of engineering construction;
secondly, as a source of heat and power;
thirdly, as raw material for plastic and cellulose industries;
fourthly, as food and fodder;
fifthly, as raw material for the manufacture of chemical by-products.

Several fields of present or prospective avenues of utilization of timber as a structural material are described. Reference is made to the significance of the use of modern connectors for timber joints in bridge and roof trusses. The field for wood as a source of power, for stationary as well as moving engines, is described. The best three fields for timber utilization are very briefly described.

There are five main fields for timber utilization, which are as follows:

1. As a structural material that can be employed practically for every kind of engineering construction.
2. As a source of heat and power.
3. As raw material for plastic and cellulose industries.
4. As food and fodder.
5. As raw material for the manufacture of chemical by-products.

Some of the latest developments in the utilization of timber as a structural material relate to the following:

(*i*). Bridge trusses, roof trusses, radio towers and other such heavy engineering structures employing modern timber connectors.

(*ii*). Laminated construction for bridge and roof trusses.

(*iii*). Manufacture of waterproof plywood.

(*iv*). Insulation boards.

(*v*). Prefabrication of timber houses.

(*vi*). Portable parquet flooring.

(*vii*). Branch-wood blocks for road construction.

(*viii*). Manufacture of hardened wood for special purposes.

(*ix*). Developments in the marketing of fencing material.

(*x*). Utilization of jointed coniferous poles from the Himalayas for electrical transmission.

(*xi*). Wooden piles.

Modern timber connectors.—The scientific use of modern timber connectors has made it possible to reduce considerably, consistent with strength, the volume of timber required in roof and bridge truss construction, besides, making for the first time in the history of timber utilization, certain economical and efficient types of truss construction possible. With bolted joints it is not possible to realize more than 50 to 60 per cent of the allowable working loads for tension members in timber-framed structures. Timber structures which were considered hardly possible about 20 years ago have now become a successful reality. Employing modern timber connectors, self-supporting radio towers built of timber up to a height of 550 feet and roof trusses with spans up to 250 feet have been installed and used with success. Instead of employing the traditional steel and wood composite Howe form of truss for bridges, the more economical Pratt truss has become practicable. The great weakness of timber in construction work, employing bolts, has been due to its tendency to failure in shearing stress before the full tensional or compressional strength of the members is developed. By the employment of modern connectors, it is possible to transmute the shear stresses developed at truss joints with ordinary bolts into a pure compressional stress, and steel bolts are employed mostly for keeping the connectors and the timber pieces in position. The main idea is, however, not new as rectangular dowels for resisting shear have been employed for several hundred years. Experiments made recently, at the instance of the Timber Development Branch, have indicated that the use of bamboo, especially those cut at the knots, offer great potentialities for use as modern timber connectors. By using them for even heavy engineering structures, it would appear that bolts of a diameter more than $\frac{1}{2}$ inch will not be necessary. Prefabricated wooden roof trusses of even comparatively large spans can be fabricated economically with such efficient joints.

Laminated construction.—Timber in the past has been used mostly either in rectangular or circular (natural) cross-section for structural purposes. As a result of the great progress that has been made during recent years in research on glues and laminated construction, it is now possible to obtain practically any economical cross-section that is required or dictated by engineering considerations not only across a beam or a column but along their length. As far

as indoor construction is concerned, it would appear that casein glue can be thoroughly relied on in laminated construction. In outdoor construction, there is no doubt that a Bakelite "glue," like "Tego," will make the joints entirely waterproof, but there are certain limitations in the actual employment of Bakelite "glue" that make it practically useless, for the present, for use in structural construction. The most important limitation of such "glues" is the imperative necessity for heating the wood faces for being bound in adhesion to obtain the requisite strength. Experiments are being made in Germany to develop a cold Bakelite-like resin, but, so far, no such glue has been developed that will remain stable in the tropics even for a few days. The best adhesive of this type, so far known, decomposes within five or six weeks even in a cold climate.

It may perhaps be mentioned in this connection that a laminated foot bridge, which was made about two years ago at the Forest Research Institute, has still got its laminations almost completely intact although the bridge has been exposed to about 100 inches of rain last year and to about the same rainfall during this year. We are keeping the bridge under observation, and if for another two years, without any protective waterproofing coating being given to the laminations, they remain intact, it will very probably be possible to recommend the use of that type of construction for bridges in dry or moderately dry localities in this country. As the planks or laminations of laminated structures can be antiseptically treated much more easily than thick timber, only if lamination joints can resist the action of the elements, there is an enormous scope for such construction in outdoor structures as the principle of the arch can be used on an extensive scale.

Manufacture of waterproof plywood.—The manufacture of waterproof plywood owes its origin to Germany where waterproof synthetic resins for gluing wood were employed and developed. Outside Germany, the possibilities of the manufacture of waterproof plywood received a ready response in the United States of America where there are now several plywood plants making this type of plywood. When it is realised that plywood, weight for weight, is sronger than steel, and when it is appreciated that waterproof plywood has now been placed on the market, one can easily imagine the numerous uses to which such a product

can be put. Waterproof plywood has been used for exterior walls in prefabricated house construction, for motor bus and trailer construction, panelling for walls and ceilings, for aeroplane fuselage, insulation boards, forms in reinforced concrete construction and for various parts in furniture manufacture where large humidity-resistant surfaces are required. There is a great future for the use of waterproof plywood in outdoor construction. Such plywood, if antiseptically treated, can be expected to be more resistant to the elements than even ordinary steel plate.

Insulation boards.—Insulation boards with mechanically shredded timber or with wood excelsior in combination with waterproofing or cementing chemicals like asbestos, sodium silicate, magnesium oxychloride and others are an important product of recent scientific and industrial research. A typical wooden insulation board made without chemically disintegrating the wood but only shredded by a physical method, employing high steam pressure and temperature, is Masonite. There are several boards of this type which are on the market. There are some which are made of wood flour, asbestos and ordinary cement. Any kind of wood waste, after being mechanically ground, can be used for such boards. Wherever cheap electric power is available in the vicinity of softwood forests, there is scope for the manufacture of this type of boards. Such boards offer certain advantages over wood planking as well as over plywood. Very few of them are, however, entirely waterproof, but they afford a very high degree of insulation against heat, cold and sound. Boards which are made of wood excelsior, sodium silicate and cement have recently come into vogue as an insulation lining for concrete buildings and as a base for stucco finish for the exterior of buildings. Their average weight is only 24 lbs. per c.ft. and are becoming increasingly popular in localities which are visited periodically by earthquakes.

Prefabrication of timber houses.—Prefabrication of timber houses is not entirely new to the timber industry. The economical and industrial conditions that have prevailed during the last decade have been responsible for helping to place this industry on a more scientific and rational basis. One of the earliest and well-known achievements in this type of construction was evinced in connection with the housing scheme of Stockholm, about ten years ago. There are at present several firms in Europe and America which have been

evolving efficient types of prefabricated units that are suitable for the construction of residential, labour, school, military and industrial buildings as well as of week-end huts. There is undoubtedly a great field in this direction. The Forest Research Institute, Dehra Dun, tried to demonstrate the potentialities of fabrication of timber houses when they put up at the recent Lucknow Exhibition an all-timber prefabricated house, the framework of which was first put up at Dehra Dun. There appears to be a great field in this country for the manufacture of this type of houses and cottages especially for sale in the hills and for week-end houses in the vicinity of provincial capital cities and large industrial places. The Timber Development Branch has recently designed a prefabricated camp house which can also be used in the construction of barrack buildings.

Portable parquet flooring.—There is another use of timber in the constructional line which bids fair to give rise to a new industry in this country. It was about nine months ago that the Timber Development Branch prepared a wooden parquet floor, by mounting over jute cloth $4'' \times 2'' \times \frac{1}{4}''$ pieces of hardwood by means of casein glue under pressure. The original panel which measures $4' \times 2'$ has been through one summer as well as a rainy season. Further experiments are in progress.

Branchwood blocks for road construction.—The Deidesheimer method of road construction has become increasingly popular in Central Europe during the last three or four years. Several hundred miles of bicycle roads, connecting villages, besides ordinary highways have been constructed in Germany and other Central European countries employing this method. It is only economical in this country where good stone metal is not available in the vicinity and where cheap surplus fuel wood is available. According to this method, branchwood of about 3 to 4 inches in diameter is cross-cut into 3-inch long pieces, which are laid over a clay stratum. Asphalted gravel is rolled over the blocks which keeps the blocks together to form an efficient wearing and cementing surface. A road of considerable resistance to abrasion, high resilience and freedom from dust results.

Manufacture of hardened wood for special purposes.—The injection of synthetic resins into beech wood by a certain patented method has made it possible to increase the strength of wood by several hundred per cent. However, a field for the use of such

artificial, hardened wood called "Ligno-stone" is so far not very extensive because of the yet comparatively high cost of processing.

Developments in the marketing for fencing material.—There is a great field for the use of treated wood for fence pales and fence posts. Inter-woven fencing with $\frac{1}{4}$ inch thick and 3 or 4 inches wide wood strips is a recent European development with possibilities for application to India. There is a field for timber manufacturers in India to place on the market bundles of fence equipment, each containing fence pales for an eight-foot bay along with one fence post and two eight-foot long horizontal bearers to which the house-owner can, himself, nail pales on the spot. Such packets make it easy for transportation and for stocking purposes.

Utilization of Himalayan coniferous poles for electrical transmission.—There is another development which should be of great interest to forest officers. It relates to the utilization of treated wooden poles in electrical construction. During the last two or three years nearly 14,000 treated electrical wood poles have been installed in India. Most of the poles have been of sal, chir, baliga or teak. As a result of personally approaching the various provincial electrical inspectors in this country, the ban which previously existed on the use of treated timber poles in electrical construction has been removed. There is now a large and lucrative field open for treated wooden poles. A peculiar problem which has been hardly encountered in any country in the world presented itself as soon as customers started asking for good straight wooden poles. Sal and other hardwood poles are not straight enough to satisfy punctilious customers of urban electric service as the eye of towns-people has been used to seeing mathematically straight metal poles. Practically all our straight coniferous poles are obtainable only in the hills. On account of sharp curves in hill roads and hill streams, it has not been possible to extract and bring down to the plains poles longer than 20 feet. To tap the straight coniferous pole wealth of the hills, it has become, therefore, absolutely imperative to evolve an economical and efficient pole joint so that poles can be extracted in lengths not exceeding 20 feet by lorries or flotation and the pole halves jointed together in the plains. It is gratifying to report that the Timber Development Branch has recently succeeded in developing such a joint. As a result of this important development, it is expected

that an extensive utilization of coniferous thinnings from the hill forests of the United Provinces and the Punjab will soon become possible.

There has been no objection raised against the use of fairly straight hardwood poles for electrical transmission and distribution in the countryside, but for service in towns and cities, a hardwood pole is usually not accepted. Forest officers may be interested to hear that the town of Fyzabad has been recently electrified by the employment of about 600 Ascu-treated chir poles that were supplied by the United Provinces Forest Department to Messrs. Callender's Cable & Construction Co., Ltd., who did the treatment and the erection. To indicate how difficult and expensive it is to extract long chir poles from the hills, an example based on the experience of Messrs. Callender's Cable & Construction Co., Ltd., in extracting over 600 poles from the Mussoorie hills may be cited. Although the haulage distance is not more than about 15 miles, the average cost of bringing 38 feet long poles from the hills to the company's treating plant in Dehra Dun has worked out at about Rs. 12 each. Due to difficulties encountered as regards labour, etc., only a few hundred poles have been extracted. It has been stated that if the poles can be cut into halves, the cost of extraction would not have been more than about Rs. 5. Besides the saving on freight, the most important point to remember is that coniferous poles which cannot by any inexpensive method be extracted at all from the hill forests can now be placed on the market in the plains in thousands for the first time because poles can be extracted in lengths not exceeding 20 feet. Motor lorries can carry poles up to 20 feet in length over hill-roads, besides being possible to negotiate this length in rivers if poles are floated. The three most favourite lengths in electrical, telegraphic and telephone construction are 36, 28 and 21 feet.

Wooden piles.—An important development, as a direct result of the universal availability of efficient antiseptic pressure treatment facilities, is the field that has opened out for foundation timber piles which can now be used with economy and efficiency for supporting buildings, bridges, irrigation structures, etc., right up to ground level. If the antiseptic treatment is carried out properly, there is no need for the top of the pile to be cut off at the permanent "level of saturation," but it can reach the ground level without any risk. It may be interesting to note that, annually, about a lakh of untreated

sal piles are used in and near Calcutta where the level of saturation is very near the ground level. There is a great field for the employment of treated timber piles not only in engineering construction but for reclamation of valuable land at the mouths of the great rivers in this country and near backwaters on the West Coast.

Wood as a source of heat and power.—The utilization of wood, especially of "hardwood" timber species as a source of heat and power is in one sense very old, but in the light of recent intensive research, especially in France, Germany and Italy, such utilization has become very efficient. Wood is now able to hold its own against most common materials that are used in our present civilization for power generation. It is not proposed to go in detail into this matter in the present note as an article on this subject of utilizing wood and charcoal for power purposes has been recently contributed by this Branch to the *Indian Forester* of August 1937 entitled "The potentialities of wood fuel and charcoal for cheap power production in India." It is sufficient to note here that about 10 lbs. of charcoal or about 22 lbs. of "hardwood" or $\frac{3}{4}$ gallon of crude oil offer about the same magnitude of power as a gallon of petrol. It will, therefore, follow that about annas 2 worth of charcoal or wood can generate the same power as a gallon of petrol which costs eight to twelve times as much in most places in India. Petrol is only slightly lighter than wood charcoal for equal power generating capacity, if the two fuels are employed with moving vehicles. The only disadvantage of charcoal in moving vehicles is that the charcoal gas producer involves the carriage of a deadweight of about 350 lbs., whereas petrol is atomised directly from the carburetter so that this extra deadweight is saved. From the timber utilization point of view as well as that of rural economics, this matter of cheap power generation from wood or wood charcoal is of immense importance. In the case of stationary power generators, the question of relative weight of fuels for power generation has no practical significance especially as wood and wood charcoal need not be carried over long distances as in the case of imported fuels. Trees or parts of them which are not useful for any purpose other than for fuel can be employed for power generation purposes. Wood from coppice forests can be utilized. The making of charcoal by villagers can be built into a profitable industry enriching the countryside. In Germany, there are 800 wood block loading

stations that have been installed at about 80-mile intervals on all the important highways in the country. France and Italy have been following suit. In the latter country a decree has been recently passed that by the end of the present year no imported petrol or other fuel should be used for driving stationary or moving engines. Only indigenous substitute fuels will have to be employed. Undoubtedly two of the most important substitute fuels are wood and wood charcoal.

Burma is now a foreign country and the bulk of petrol consumed in this country is imported from Burma. As petrol enjoys almost a monopoly for power production for driving motor lorries, the prices of these two fuels are bound to soar high in the event of a war breaking out. As these fuels have a high calorific value and require very light and simple apparatus to gasify, they are in great demand for naval and aircraft purposes. In case war breaks out, it will be very difficult to obtain such fuels in requisite quantities. There is hardly any important alteration required in ordinary motor cars to adapt them for use with wood or charcoal gas. If some modifications (the most important of which is a reduction in cylinder head space) are made, the efficiency of engines actuated by wood or charcoal gas is hardly inferior to that of petrol-driven engines. In the case of Diesel engines, worked by crude oil, there is hardly any modification required to adapt them to work with wood or charcoal.

As regards generation of heat from wood, several types of slow-burning ovens have been placed on the German and Austrian markets. The main principle of construction of these ovens is that the fuel gases are impelled, by means of baffles, to pass out along a circuitous path so that most of the heat gets abstracted. Water coils accommodated inside such stoves are employed for heating the house.

As wood and charcoal gas generators and engines for stationary purposes have been placed on the market for as low as 2 h.p., they appear to be ideal for irrigation and other purposes in the country-side.

It is interesting to note that the well-known Bombay firm of Kirloskar's have been making charcoal gas producers for some years, and that over a dozen motor lorries in the Madras Presidency have been running on wood charcoal.

As for the remaining three fields of timber utilization, Dr. Von Monroy, a German authority on the subject, says as follows:

"The production of alcohol from wood is another interesting field of use. Six to eight gallons of alcohol are obtained from 2 cwt. of wood according to the kind of wood and the plant used. Investigation has shown that the benzol obtained from wood is especially resistant to frost and of considerable importance for aviation, and the same efficiency of extraction is possible. The process is, however, in its inception and not yet developed for industrial use. In regard to the use of alcohol produced from wood, experience in Sweden and Germany has shown that an admixture of about 25 per cent alcohol to the petrol is desirable in order to attain efficient combustion in the engine.

"The last decade has shown great progress in the use of wood to obtain cellulose and filaments. The wood filaments, formerly only of importance for papermakers, has begun to oust wool and cotton in many spheres of use, after having already supplanted silk. The insulating properties of wood filaments have recently been improved, and the manufacture of blanketing and similar materials exclusively from wood filaments has reached a successful stage. Wood has proved to be a suitable material for the production of hard filaments as well, and means have been found to produce jute for many purposes from wood fibres.

"The utilization of wood for the production of food and fodder substitutes is extremely interesting. Research made in Germany has resulted in the devising of processes to extract not only sugar for feeding animals but also for human consumption, and moreover it is possible to produce a fodder rich in albumen. Extensive tests have demonstrated that the so-called fodder-sugar is quite disgestible as a carbo-hydrate food, and that the yeast obtained from wood is a substitute for the soya bean. It is well known that a supply of albuminous fodder is essential for the northern countries to ensure an adequate supply of fats. The fodder-sugar can be produced at very low prices, but the costs of producing yeast from wood are uneconomical and the finished product is more expensive than soya; however there are developments to be expected in this direction and a reduction of costs will be possible. This is especially illuminating, when one thinks of the extraction of nitrogen from the air, begun during the war, and which seemed at first suitable only for abnormal times, but which now is in a competitive position."

CHARCOAL BURNING IN IRRIGATED PLANTATIONS

By R. S. Chopra, P.F.S.

Abstract.—The note describes the method of charcoal-burning in the Punjab irrigated plantations and the type of kilns used. The yield of charcoal and financial prospects of burning are also discussed.

Charcoal-burning has extensively increased in south-western parts of the Punjab during the last five years or so. Batteries of kilns installed amidst huge piles of firewood close to a number of wayside railway stations could hardly escape one's notice in a train journey from Lahore to Multan. The industry, no doubt, has received a great stimulus from the rising demands of the increased population in towns, but its recent spread is from the large stocks of firewood having been liberated by the disforestation of a vast area of dry *rakhs* for colonisation under irrigation schemes. This wholesale clearance of scrub areas in the newly-formed Canal Colonies glutted the market with firewood of all sorts and dislocated the fuel trade for some time, causing a serious depression. Some of the irrigated plantations formed by the Forest Department came into being under these adverse conditions and had to face an unlooked for competition which greatly deferred our hopes of a quick return. Plantations were mostly situated at a long distance from big towns, the main centres of fuel consumption, and the expense involved on the delivery of the produce in the markets left but little margin of profit with the heavy fall in prices. So the disposal of firewood from such areas as well as similarly situated disforested *rakhs* became a problem with the purchasers in this slum period. Withholding the stock meant blocking of capital and depreciation of firewood which was subject to rapid decay, particularly through white-ants in these arid tracts. Charcoal-burning offered itself as a ready solution for the disposal of a part of the stock at any rate, and was taken up by most of the firewood contractors as a side business. It has since stayed on and made steady progress with the march of time and creation of fresh demand, although the fuel market is well on its way to gradual recovery.

The charcoal is burnt in paraboloidal kilns of varying sizes and shape. The improved type of kilns met with in Daphar and

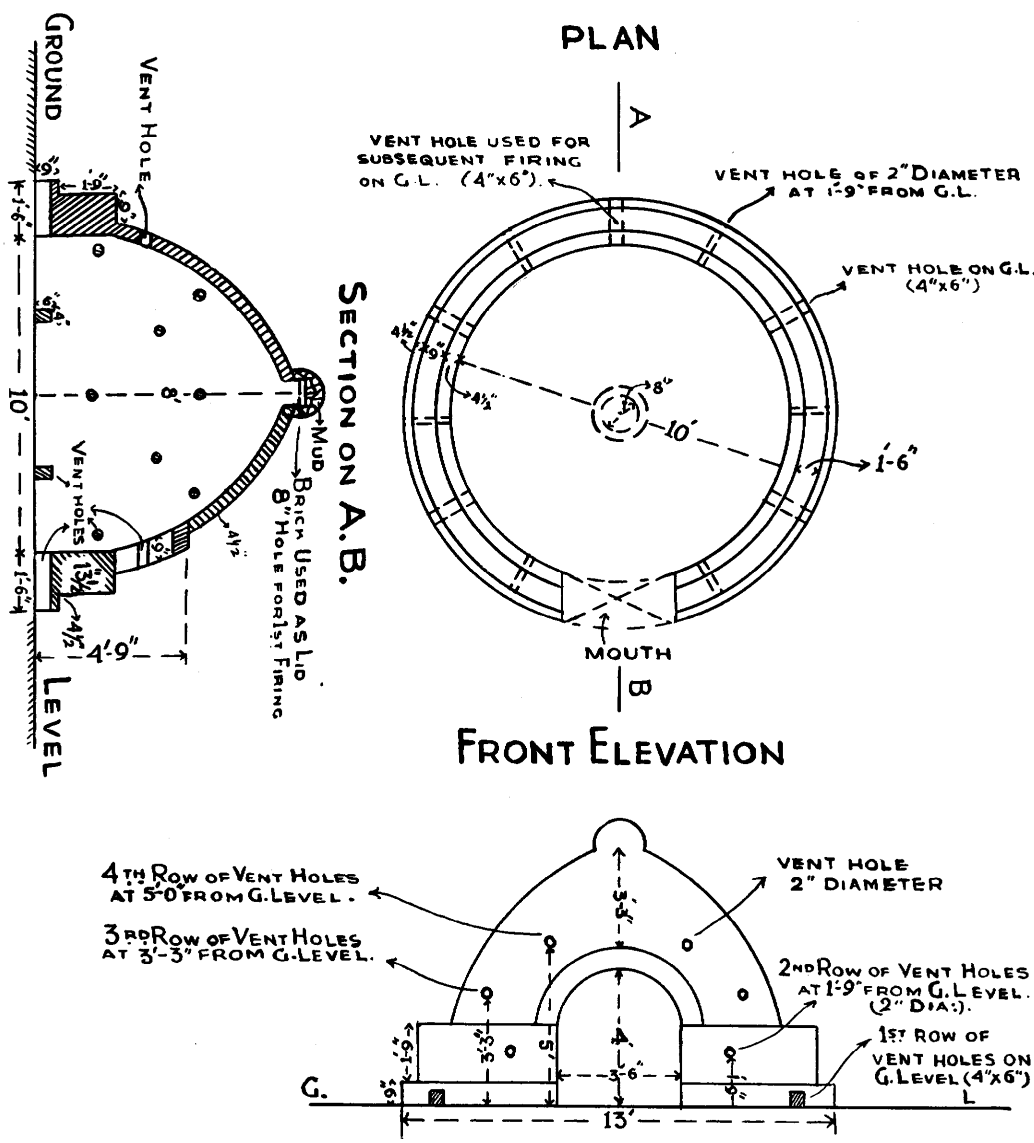
Chichawatni plantations are illustrated in the accompanying diagram (plate 28) and their construction and working described below.

Kiln construction.—The kilns are made of *kacha* (unburnt) bricks, mud plastered and finished with *gobri* (mixture of cow dung and earth) *leaping*. Their usual size is about a height of 8 feet and an inside diameter at the bottom of 9 to 12 feet. The dome starts at 2½ feet above ground, the lower portion is built almost cylindrically straight, the upper part being slightly inclined inwards. This device adds to the durability and capacity of the kiln and provides a greater facility in the loading and unloading operations. The lower circular portion is made rather stronger in order to secure a firm footing for the dome above. The width of the wall for this part varies from 13½ to 18 inches, *i.e.*, 1½ to 2 bricks thick, generally the former. The two-brick thickness is rare and, when used, is continued only up to a height of 9 inches above ground so as to form a sort of plinth for the structure. The dome is only 4½ inches thick except for the arch of the mouth extending into it which is 9 inches thick (*c.f.* section on A. B.).

In the actual process of construction the lower 2½ feet high circular enclosure is built first of all after clearing and levelling the site. Space for the mouth is left unwalled. No foundation is dug up. Firewood packing is then started to define an outline for the remaining structure. The billets are 2½ feet long and usually three rows placed on edge make up the body of the kiln. The billets in the bottom row are arranged upright and in the top two rows slanting so as to form the dome. Packing is done as tight as possible, thicker pieces are packed at the bottom and interstices filled up with bark and chips to facilitate burning. Particular care is taken in initial packing as the structure forms the framework for the construction of the upper spherical portion of the kiln. A smooth, solid and symmetrical packing is needed because a dome constructed on uneven or shaky surface is likely to collapse or burst open. When packing is over the construction of the roof is completed by brick on edge masonry (single layer) covering the firewood frame and the outer surface is finished with mud plaster. The kiln gets baked in the first burning and remains serviceable for years if properly looked after.

PLAN OF CHARCOAL KILN IN PLANTATIONS.

SCALE 1" = 4 FEET



Vent holes and mouth.—The entrance for loading and unloading is kept $3\frac{1}{2}$ feet wide and 4 feet high with a semi-circular arch 9 inches thick on top to prevent any damage to the roof in handling the firewood or charcoal. Twenty-four vent holes arranged in four rows are provided for the exit of smoke. There are six holes in each row equally distanced. The bottom-most row is at the ground level, and the holes are $6'' \times 3''$ in size. The next three rows occur at a distance of $1\frac{3}{4}$ feet, $3\frac{1}{4}$ feet and 5 feet above ground with holes about 2 inches in diameter. The apertures in each row are so placed that they do not fall vertically in line with those in the row immediately above or below.

Burning.—The new kiln is fired from the top for the first time through an opening, about 8 inches in diameter, kept for the purpose at the time of construction, and packed with inflammable material. This aperture is closed for ever when its function is over. Subsequent loading is done *via* the main entrance, which is walled with bricks and plastered with mud after packing. The firing is now done from the bottom through the vent hole opposite the mouth. This hole is selected for firing in preference to the one in the entrance as the latter is likely to be wet after mud plastering of the mouth.

Whether fired from above or below the burning proceeds from top downwards. The first row of holes along the top are closed when the load catches fire satisfactorily in about two to four hours of setting the kiln on fire. Some people choose to keep the top row of holes closed after the first firing. The next row of holes from the top are closed after seven to twelve hours of firing when the burning reaches their level. Then follows a process of slow and controlled burning wherein the skill of the supervisor plays its part. The vent holes in the next two rows are partially closed or opened from time to time to regulate the draught, aiming at a thorough and even burning. Complete burning takes about a week and is signalised by the issue of characteristic bluish smoke with which every charcoal burner is so familiar. All the smoke outlets are then closed, those in the second row from bottom last of all, and the kiln is allowed to cool. During this period a solution of clay and water is poured on the kiln about two or three times daily to hasten the cooling operation. A thicker solution is used for the first time to fill up cracks, if any. Cooling takes nearly four days after which the mouth is opened and charcoal taken out,

When opening the kiln, precaution is taken to see that no live sparks are left inside which may set the charcoal on fire with the ingress of fresh air.

Yield of charcoal.—The yield varies with the species, the size and thickness of billets and the moisture contents of firewood. The species used for charcoal-burning are *kikar* (*Acacia arabica*), *jand* (*Prosopis spicigera*), *shisham* (*Dalbergia sissoo*), *farash* (*Tamarix articulata*) and to a limited extent mulberry (*Morus alba*). *Shisham* and *jand* are by far the most commonly used and produce a high grade charcoal for cooking and heating purposes. Weighments recorded on four kilns in Chichawatni and Changa Manga plantations show that dry *shisham* firewood, billets 2½ feet long, 2 to 10 inches in diameter, yields about 27 maunds of charcoal per 100 maunds of firewood, the outturn falling to 24 maunds with 5 feet long pieces. The corresponding yield per 100 c.ft. stacked volume of firewood was 10 and 7 maunds respectively for 2½ feet and 5 feet billets.

Green firewood gives about 3 to 5 per cent higher outturn but the charcoal obtained is known to crack, is more friable, and fetches lower rates.

General.—To run on commercial lines a set of 24 to 26 kilns is looked upon as an economic unit. This makes it possible to charge two kilns daily, considering that it takes a week to burn, four or five days to cool and a day to empty and reload a kiln. The set is operated by one skilled *mistri* on Rs. 30 to Rs. 40 per mensem to supervise burning and a gang of nine coolies each getting about Rs. 12 per mensem. Six coolies are employed on loading and unloading the kilns, two on weighment and packing of charcoal and one on pouring the mud liquid used for cooling. The *mistri* could supervise another set if required. Accounts are invariably kept by the contractors themselves, otherwise a clerk is needed.

A kiln costs about Rs. 10 to make and uses up 2,000 to 3,000 *kacha* bricks. If carefully handled it is calculated to last for 10 to 15 years or even longer. Annual repairs cost about Re. 1 and generally consist in scraping off and renewing the mud plaster on the outer surface. The initial outlay in putting up a set of 25 kilns comes to about Rs. 600 exclusive of firewood supply, Rs 250 on the construction of kilns and the rest on a water pump and a few temporary huts for the labour.

Lahore and Amritsar are the main markets where charcoal in any quantity produced so far has found a ready sale. The trade is rather brisk in winter and the charcoal burners usually restrict their activities to this season, starting burning somewhat in advance to lay-in stock. The manufacturing cost of charcoal at current firewood rates work out to Re. 1-4-0 per maund at the outside inclusive of conversion and marketing charges detailed in the enclosed schedule of cost for Chichawatni plantation. The sale rates at Lahore vary from Re. 1-8-0 per maund in summer to Rs. 2 per maund or even higher in winter. People reaped a good harvest in the past few years when the price of firewood did not count much but now its scope is limited to winter months when only a reasonable return could be expected. All the profit, however, does not go into the pocket of the producer. There is the insidious middleman to be reckoned with. His ingenuity has devised a system of heavy (15 per cent) discount to be made on the weight of charcoal at the time of sale to allow for depreciation in transit, *i.e.,* payment is made for 85 maunds for every 100 maunds of charcoal delivered. Spreading the total scheduled charges of Rs. 125 on 85 maunds, the cost price goes up to over Re. 1-7-0 per maund. Apparently with present rates, more often than not the producer appears to sweat for a petty gain, while the middleman gets the lion's share as ever through his business acumen.

I am indebted to L. Chuni Lal, Forest Ranger, Chichawatni, for the collection of costing figures.

Schedule of cost on the manufacture of 100 *maunds shisham charcoal in Chichawatni plantation and its delivery in Lahore,* 129 *miles.*

A—Conversion Charges—	Rs.	a.	p.	
1. Felling, billeting and stacking of 1,000 c.ft stacked firewood in the forest	13	0	0	
2. Carriage of firewood from forest to railhead depot	6	4	0	
3. Loss in transit (10% of items 1 and 2) ...	1	15	0	
4. Stacking in the depot	0	15	0	
5. Royalty to Forest Department @ Rs. 5-9-0% c.ft. (current rate)	55	10	0	
6. Loading and unloading the kilns including burning of charcoal	2	0	0	
7. Cost of establishment, ground rent, interest charges, etc.	2	0	0	
Total A Charges ...	81	12	0	or
	0	13	0	per maund.

B—Marketing Charges—	Rs.	a	p.
8. Cost of 125 old gunny bags for packing charcoal @ 0-1-0 per bag	7	13	0
9. Weighing the charcoal and packing in bags	1	8	0
10. Loading in the wagon and siding charges ...	1	12	0
11. Railway freight to Lahore	15	0	0
12. Carriage from railway station to sale depot in Lahore @ 0-1-0 per maund	6	4	0
13. Octroi duty at Lahore @ 0-0-6 per maund ...	3	2	0
14. Brokerage @ 0-1-0 per maund	6	4	0
15. Miscellaneous charges	1	9	0
Total B Charges ...	43	4	0 or
	0	7	0 per maund.
Grand Total ...	125	0	0
Cost per maund ...	1	4	0

FOREST RESEARCH INSTITUTE AND COLLEGE—ANNUAL SPORTS (Illustrated).

A combined athletic meeting of the staff of the Forest Research Institute and students of the Indian Forest Rangers College was held on Saturday, the 26th March 1938. A beautiful track was laid out on the lawns in front of the main building. Mr. and Mrs. Mason and the officers of the Institute and College were "At Home" to their friends and a very enjoyable afternoon was spent.

Besides the various races, the high jump, the hurdles, the sack scrimmage, the obstacle race and the spar-fighting, the programme included inferior staff race, the officers' handicap race, two races for the children and ladies' egg and spoon race, the last being an addition over the previous year's programme.

Our thanks are due to Major Hudson who acted as the chief starter most admirably. Major Hudson also arranged an exhibition by the Gentlemen Cadets of the Indian Military Academy for putting the weight, throwing the cricket ball and hurdles race. This was most instructive to the boys and the staff who took part in the sports,

Ladies egg and spoon race.

Ladies egg and spoon race.

Officers race.

High jump.

The majority of the prizes went to the students of the College this year. The Championship Cup was won by H. C. Pant, one of the students at the Indian Forest Rangers College. The programme was kept to time and Mrs. Mason gave away the prizes.

After the distribution of prizes the function came to a close with three cheers for Mrs. Mason.

The names of successful competitors are given below:

Long Jump ...	... M. S. Rana (F.R.I.)
	H. C. Pant (F.C.)
Putting the Weight	... S. K. Roy (F.C.)
	Mohd. Haider Khan (F.C.)
Throwing the Cricket Ball	... S. K. Roy (F.C.)
	M. S. Rana (F.R.I.)
High Jump ...	... K. Kerr (F.R.I.)
	H. C. Pant (F.C.)
100 Yards Race ...	... H. C. Pant (F.C.)
	G. S. Rana (F.R.I.)
Hurdles Race ...	... H. C. Pant (F.C.)
	Nurul Hasan (F.R.I.)
Sack Scrimmage ...	... Mohd. Yusuf (F.C.)
	Mumtaz Ali (F.C.)
220 Yards Race ...	... H. C. Pant (F.C.)
	Vidya Sagar (F.C.)
Tug-of-War ...	... Indian Forest Rangers College.
Relay Race ...	... Forest Research Institute.
Officers' Race ...	... Dr. N. L. Bor (F.R.I.)
	Mr. L. Mason (F.R.I.)
Ladies' Egg and Spoon Race	... Mrs. Mason
	Miss Farrar
	Mrs. Madan
Half Mile Race ...	... M. S. Rana (F.R.I.)
	Mohd. Hanif (F.C.)
Obstacle Race ...	... Indrapal Singh (F.R.I.)
	Nurul Hasan (F.R.I.)
Spar-Fighting ...	... R. K. Pandey (F.C.)
	Nurul Hasan (F.R.I.)

1. The Forest Football Challenge Cup—Winners 1937: Forest College (Cup presented by Sir Alexander Rodger).

2. The Mason Jaspal Hockey Cup—Winners 1937: Forest College.
3. R. K. Banerji Memorial Cup for Badminton—Winners 1937:
   Mr. N. S. Sissodiya.
   Mr. Om Prakash.
   Runners-up: Mr. D. R. Sood.
   Mr. K. Kerr.
4. Seaman Cricket Cup—Winners 1937: F.R.I., Timber Testing Section.
5. Volley-Ball Cup—Winners: Champions (Boys Team).
6. Tennis—Men's Open Singles (Cup presented by Mr. A. D. Blascheck)—Winner: Mr. S. K. Kukreti.
   Runner-up: Mrs. Madan.
7. Tennis—Men's Open Doubles (Cup presented by Mr. L. R. Sabharwal)—Winners: Mr. N. C. Chatterjee.
   Mr. A. L. Sabharwal.
   Runners-up: Mr. W. T. Hall.
   Mr. Balwant Singh.
8. Men's Handicap Singles (Cup presented by Mr. W. T. Hall) —Winner: Mr. U. S. Madan.
   Mr. H. C. Pant.
9. Men's Handicap Doubles—Winners: Mr. W. T. Hall.
   Mr. Mumtaz Ali.
   Runners-up:—Mr. H. C. Pant.
   Mr. Vidya Sagar.

INDOOR GAMES

10. Game of Twenty-nine—Winners: Mr. K. N. Tandan.
    Mr. Cheda Lal.
11. Auction Bridge—Winners: Mr. D. D. Kalera.
    Mr. Dalip Singh.
12. Carrom—Winners: Mr. N. S. Sissodiya.
    Mr. A. K. Sen.
13. Ping-Pong—Winner: Mr. N. S. Sissodiya.
    Runner-up: Mr. Indra Mohan Bakshi.
14. Chess—Winner: Mr. Harbans Singh.

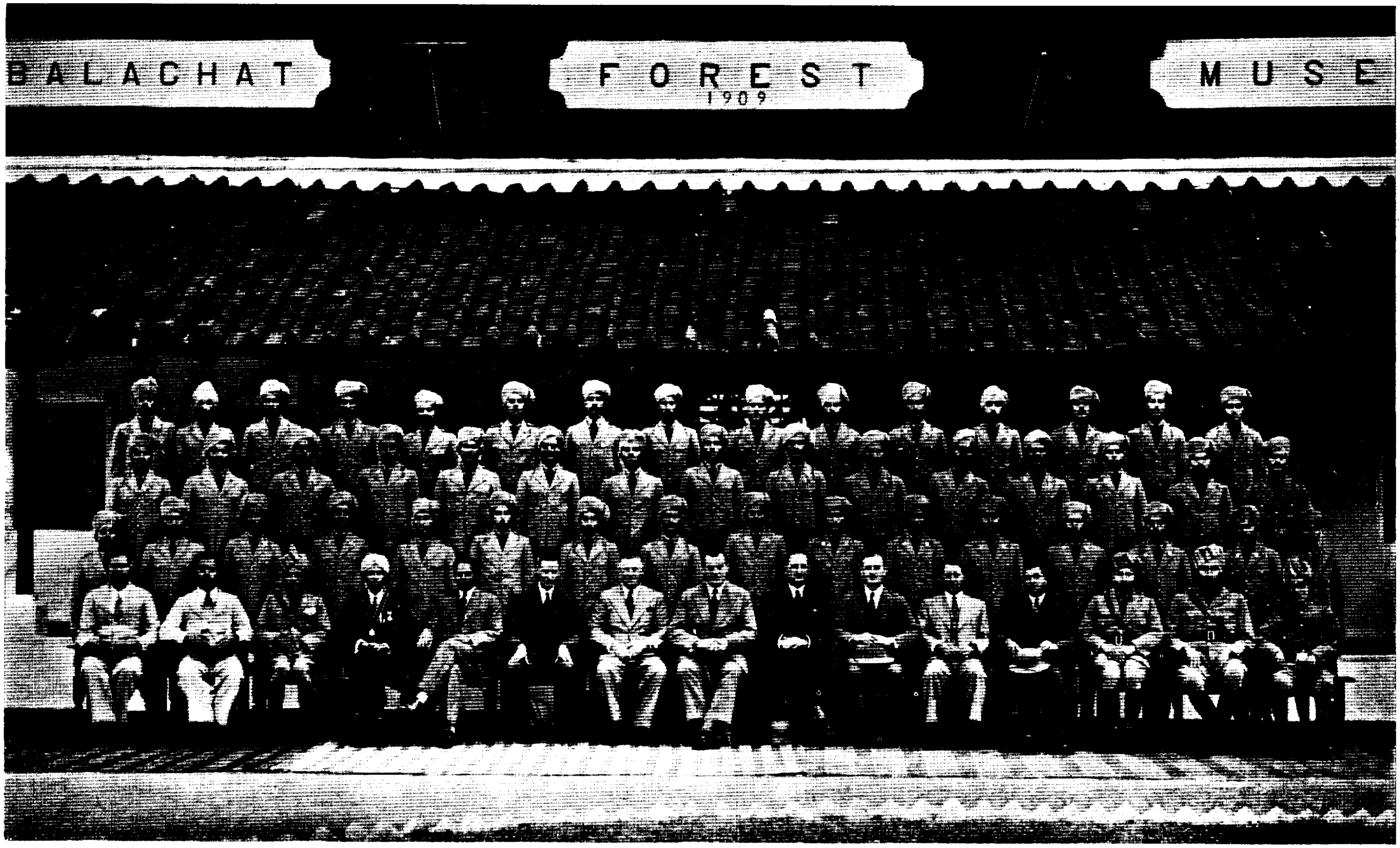
TIMBER PRICE LIST, APRIL-MAY 1938
(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE)

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Assam ..	Logs ..	Rs. 30-0-0 per ton in Calcutta.
Benteak ..	*Lagerstrœmia lanceolata*	Bombay ..	Squares ..	Rs. 32-0-0 to 80-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-15-0 to 1-8-0 per c.ft.
Bijasal ..	*Pterocarpus marsupium*	Bombay ..	Logs ..	Rs. 44-0-0 to 84-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-11-0 to 1-5-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 1-0-0 per c. ft.
Blue pine ..	*Pinus excelsa* ..	N. W. F. P.	12′×10″×5″ ..	Rs. 4-8-0 per piece.
,, ..	,, ..	Punjab ..	12′×10″×5″ ..	Rs. 4-12-0 per piece.
Chir ..	*Pinus longifolia* ..	N. W. F. P.	9′×10″×5″ ..	Rs. 1-14-0 per piece.
,, ..	,, ..	Punjab ..	9′×10″×5″.	
,, ..	,, ..	U. P. ..	9′×10″×5″ ..	Rs. 3-4-0 per sleeper.
Civit ..	*Swintonia floribunda* ..	Bengal ..	Logs ..	Rs. 25-0-0 per ton.
Deodar ..	*Cedrus deodara* ..	Jhelum .	Logs.	
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	Rs. 4-4-0 per piece.
Dhupa ..	*Vateria indica* ..	Madras ..	Logs.	
Fir ..	*Abies and Picea* spp. ..	Punjab ..	9′×10″×5″.	
Gamari ..	*Gmelina arborea* ..	Orissa ..	Logs.	
Gurjan ..	*Dipterocarpus* spp. ..	Andamans ..	Squares.	
,, ..	,, ..	Assam ..	Squares ..	Rs. 50-0-0 per ton.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 30-0-0 to 35-0-0 per ton.
Haldu ..	*Adina cordifolia* ..	Assam ..	Squares ..	Rs. 60-0-0 per ton.
,, ..	,, ..	Bombay ..	Squares ..	Rs. 28-0-0 to 68-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-13-0 per c. ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-3-0 per c. ft.
,, ..	,, ..	Orissa ..	Logs.	
Hopea ..	*Hopea parviflora* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Indian rosewood ..	*Dalbergia latifolia* ..	Bombay ..	Logs ..	Rs. 52-0-0 to 100-0-0 per ton.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 per c. ft.
,, ..	,, ..	Orissa ..	Logs.	
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-1-0 to 3-3-0 per c. ft.
Irul ..	*Xylia xylocarpa* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Kindal ..	*Terminalia paniculata* ..	Madras ..	Logs ..	Rs. 1-5-0 to 1-7-0 per c.ft.
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 48-0-0 to 72-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-12-0 per c. ft.
,, ..	,, ..	Orissa ..	Logs.	

Trade or common name	Species	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Madras ..	Logs ..	Rs. 0-12-0 to 0-15-0 per c. ft.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	Rs. 1-2-9 to 3-14-0 per piece.
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares.	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 50-0-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-3-0 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 20-0-0 to 75-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Rs. 0-8-0 to 1-2-0 per c. ft.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 to 4-12-0 per sleeper.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 1-10-0 to 1-12-0 per sleeper.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c. ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-12-0 per c. ft.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-2-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-14-3 to 5-4-0 per sleeper.
Sandalwood ..	*Santalum album* ..	Madras ..	Logs ..	Rs. 325-0-0 to 890-0-0 per ton.
,, ..	,, ..	Mysore ..	Logs	
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Rs. 1-8-10 per c. ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-12-0 per c. ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 31-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	Rs. 35-0-0 per ton.
,, ..	,, ..	Madras ..	Logs.	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Rs. 0-11-11 to 1-9-6 per piece.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-4-0 to 1-6-6 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs, 1st class	
,, ..	,, ..	,, ..	Logs, 2nd class.	
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-14-9 per c. ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 2-14-5 per c. ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-5-0 to 2-11-0 per c. ft.
White dhup ..	*Canarium euphyllum* ..	Andamans ..	Logs	

VERNACULAR FOREST SCHOOL, BALAGHAT, C. P.

HIS EXCELLENCY THE GOVERNOR'S VISIT AND ANNUAL PRIZE-GIVING, 4th NOVEMBER, 1937.



Standing :—1 G. S. Despandey. 2. Jaswant Singh. 3. Bhairon Prasad. 4 Jainarayan Pande. 5. Bhojraj Singh. 6. Hari Shankar Mathur. 7. Raghubir Prasad. 8. Shree Nath. 9. Mahabat Rai. 10. Y.A. Morne. 11. Roop Kishore Dubey. 12. Balsingh 13. P.B. Deshmukh. 14. H.N. Bhattacharia. 15. Vinayak Rao.

Standing :—1. Muinuddin. 2. V. S. Matkar. 3. Ram Manohar Khare. 4. Kedar Nath Chaudhari. 5. Jagmohan Prasad. 6. Attaulla Khan. 7. A. P. Bansood. 8. Vinaya Chandra Pandya. 9. Sugan Singh 10. Chiranjiva Lal Vaid. 11. Ishwari Prasad. 12. Gurbaksh Singh. 13. Moti Singh Chandrawat. 14 G. Y. Sir Kanungo. 15. Kamta Prasad.

Standing :—1. Anant Lal Verma. 2. Azim Shah. 3. Narayan Singh. 4 B M. Laghate. 5. Shiwalpuri. 6. Narayan Rao. 7. Krishan Narayan. 8. Ram Khilawan Gupta. 9. Bhagwati Prasad. 10. K. R. Ananda. 11. Tung Bhadra Singh. 12. D. K. Kapre. 13. C. G. Prohit. 14. Hamidullah. 15. S. K Waidya. 16. Jai Ram

Chairs :—1. N. S. R. Naidu, Sch. Clerk. 2. Dr. K S. Pawade, A. M. O. School 3. I. N. Dubey, Asstt. Instructor, F.S. 4. Rao Sahib L. H. Lokre, E A C. Fts. and Instructor, F. S. 5. G. G. Takle, Esq., I. F. S.. 6. H. C. Watts. Esq., I.F.S., 7. C. E. C. Cox, Esq., I.F.S., Chief Conservator of Fsts., Central Provinces and Berar. 8. His Excellency Sir HYDE CLARENDON GOWAN, Governor, C. P. and Berar. 9. H. C B. Jollye, Esq., I.F.S., Conservator of Fsts., Eastern Circle, C. P. 10. V. K. Maitland, Esq., I.F.S., M.C., Director, Forest School. 11. D. C. McDonald, Esq., I.F.S. 12. K. P. Sagreiya, Esq., I.F.S., 13. D. R. Shukla, Asstt. Instr., Forest School. 14. Hukam Singh, Asstt. Instr., Forest School. 15. Govind Prasad, Curator, Forest School.

CABINET OF CHIR PINE VENEERS EXHIBITED AT THE *LAHORE EXHIBITION*

SIR,

I enclose a photograph (Plate 31) of an interesting piece of furniture which was recently exhibited at the All-India Industrial Exhibition at Lahore.

The cabinet is made of sawn Ascu-treated chir pine veneers, and illustrates most strikingly the effects obtained with a timber usually considered to be dull and uninteresting. By treating the wood with Ascu preservative, the usually pale annual ring figuring was brought out in a striking way, and by an intelligent jointing of the veneers to form a balance pattern, some most effective results were obtained with this wood. It might also be mentioned that the veneers for this cabinet were sawn from an ordinary B. G. sleeper. The cabinet was made in the workshops of the Forest Research Institute at Dehra Dun in order to demonstrate what can be done even with a usually dull wood like chir pine, if a little intelligence and ingenuity are used.

H. TROTTER,
Utilization Officer,
Forest Research Institute.

REVIEWS

NORTH-WEST FRONTIER PROVINCE FOREST ADMINISTRATION REPORT, 1936-37

An interesting development this year was the exploitation of the *shisham* (*Dalbergia sissoo*) trees growing along the Lower Swat Canal banks. These were planted some 50 years ago and had become a valuable woodland estate. It was not until 1935, however, when Colonel Noel, Director of Agriculture, succeeded in marketing a number of selected trees that their potential value as a source of Government income was fully realised. After this the scheme gradually developed and the need arose for the services of an officer with experience of forestry, so in December, 1936, the whole project was handed over to the Forest Department. The financial success

of the scheme seems assured and the balance sheet on the first 18 months' work disclosed a profit of more than Rs. 32,000.

Sample logs of this canal bank *shisham* were made up as plywood panels by the Forest Research Institute workshops and exhibited as wall panelling in the Forestry Pavilion of the all-India Exhibition in Lahore, where it attracted lively interest and admiration. Lower Swat Canal *shisham* has been specified for the new Council Chamber at Peshawar, and will be a standing advertisement of the fine quality of timber that the province can produce. Cabinet makers in Peshawar and Nowshera are also using it and producing very high-grade furniture. There is, in fact, no question of the excellence of this timber, but like all good things it requires advertisement. In many places the Irrigation Department owns timber of considerable value for which they often obtain an inadequate return. Management of canal plantations by the Forest Department is being tried in the United Provinces and has been talked of in the Punjab. It will be interesting to watch further developments in the North-West Frontier Province.

The revision of the Galies Working Plan has recently been completed by Mr. E. S. V. Burton, who has decided upon a return to the selection system. To quote the Chief Conservator of Forests' review: "This system, in spite of certain obvious disadvantages, has worked well in the past and has never broken down completely in the manner plans prepared on more 'modern' lines not infrequently do. It is to be hoped, therefore, that the plan when finished will last its full time." The pendulum has indeed swung right away from the intense enthusiasm of 15 years ago for forcing our forests into the straight waistcoat of a strict regeneration time schedule! We should like to know whether the old or the new working plan has made any provision to meet the 30,000 c.ft. of timber and firewood which is the admitted annual loss through thefts.

The Cherat forest provides a good example of the benefits that accrue from conservation. A few years ago the Cherat forests were rapidly dwindling owing to unrestricted lopping and grazing, trees had begun to resemble stunted bushes and grass in many areas had disappeared altogether. During the short space of $4\frac{1}{2}$ years a remarkable improvement has taken place. The trees have increased in size, grass is reappearing and the water-supply has improved. It

is reported that for the first time for many years water has appeared in the swimming pool at Chappri. It is sad that such encouraging examples of natural recovery of water-supply are all too few compared with the widespread desiccation which has already resulted from the wholesale destruction of the Galies broad-leaf forests during the last 30 years. From his own observations during this period the Chief Conservator of Forests comments: "The ravines that formerly were filled with broad-leaved trees and furnished the best grazing have now largely been destroyed and eroded so that the grazing falls mainly upon the best blue pine areas." He indicates that the difficulties met with in the regeneration of blue pine which caused the breakdown of the Galies Working Plan are also connected with this ill-advised liberality which led to the destruction of the adjoining broad-leaf areas.

The Deputy Commissioner's report on the management of the Hazara village forests forms Appendix B of this report. The felling scheme prepared last year by a Naib Tahsildar, Guzaras, for the Siran chir *guzaras* does not aspire to a high standard of management, but it is definitely a step forward, as it takes stock of resources, and enables an opinion to be given more or less accurately whether, when applications for sales are received, the trees are available or not; this is an improvement on the previous system of visual estimating. But as the Deputy Commissioner remarks in his report, no real improvement is possible until the management of these *guzaras* is entirely reorganised and placed under a wholetime experienced Forest Officer. At present it is utterly impossible for the Deputy Commissioner to exercise effective control, for he has neither the time, knowledge, nor training for work which requires the services of a specialist.

The total area of these *guzaras* is considerable. At the time of settlement they were more extensive than the reserves, but they have steadily deteriorated and many of the smaller *guzaras* have disappeared altogether. Unless brought under management, destruction and deterioration will continue and the whole burden of local demand will be thrown on to the reserved forests, a burden which it is quite impossible for them to carry if they are to be maintained for the benefit of posterity. From an economic point of view it is essential, therefore, that these *guzara* forests should be brought under

proper management without further delay, not only in the interests of the owners themselves, but also for the welfare of the general public.

There are a great many printer's errors, particularly in the spelling of botanical names, and we are intrigued by one entry which reads "In the Kagan valley the trout hatchery at Shinu was maintained at a cost of Rs. 555 (Rs. 403)." Did the fish swallow the Rs. 152 change? A feature of the report is the reproduction of several excellent photographs, mostly illustrating erosion on steeps slopes, taken by Maulvi Bashir Ahmad.

R. M. G.

[During the year 1936-37, the Revenue was Rs. 4,06,991 as compared with Rs. 3,89,433 in 1935-36; Expenditure, Rs. 3,14,825 as compared with Rs. 3,02,930 in 1935-36, leaving a surplus balance of Rs. 92,166 in 1936-37 as compared with Rs. 86,503 in the year 1935-36.—Ed.]

THE PUNJAB FRUIT JOURNAL

Available from the Punjab Fruit Development Board, Lyallpur.

The first Annual Number of the *Punjab Fruit Journal* which has just been published, is a valuable addition to the agricultural and horticultural literature of the country. It has many articles of interest both in the English and Vernacular sections.

The English section, in addition to the usual pages of news, comments and seasonal hints contains articles on some aspects of the fruit industry of the country. Important among these are: Obstacles in the Fruit Preservation Industry; Cultivation of Apples and Cherries in the Simla Hills; Improvement of Mangoes in the Punjab; Canning of Fruit Juices; Cold Storage; Cultivation of minor economic crops like Coriander, Fennel (Sonf), Ajwain, Dill, Henbane, Rosha grass, Liquorice (Mulathi), Isabgol, etc., and a large number of extracts and abstracts from leading foreign periodicals. A fruit marketing scheme for improving the marketing of fruits is another interesting contribution to this issue.

The Urdu section contains about 40 pages comprising of articles such as Commercial Aspect of Fruit Gardening; Seasonal Hints; A General Horticultural Guide; Propagation of Mangoes, and several other articles on the control of diseases and pests of fruit trees. A résumé of results of experiments conducted on Citrus fruits in the Punjab under the joint authorship of the Fruit Specialist, Punjab, and the Assistant Fruit Specialist, Punjab, is an interesting feature of this section.

EXTRACTS

SOIL CONSERVATION IN TROPICAL AFRICA

By Dr. L. Dudley Stamp, Director of the Land Utilisation Survey of Britain.

The attention which has recently been given to the widespread and serious nature of soil erosion in the African continent has perhaps insufficiently emphasised two aspects of the problem. One is that the serious and rapid erosion is of recent growth—not only in large measure consequent upon the control of the continent by Europeans but also actually in danger of being increased by the very measures designed to combat it. The other is that the African cultivation has already evolved over large areas a system of farming designed to combat soil erosion and maintain soil fertility, and that the essential need is to encourage and develop this system rather than to supersede it. A recent tour in Nigeria has convinced me that the African system may hold the key to the solution of some of the most urgent problems of soil erosion in America and elsewhere.

Prior to the European partition of tropical Africa, internecine strife and the incidence of disease, both epidemic and otherwise, resulted naturally in a limitation of population and of any serious pressure on the land in purely agricultural areas, and prevented overstocking both by man and by animals on grazing land. Nowadays, population density in parts of Southern Nigeria reaches more than five hundred to the square mile, whilst the number of cattle in Kenya increased from three to six million between 1920 and 1936.

In Southern Nigeria, a land of adequate rainfall (60 to 150 inches or more) naturally clothed with high forest but where certainly less than one per cent of virgin forest remains, the land is divided up between the village communities. Each village tract—in other lands one would say parish—is held communally and farmed on a well-marked system of rotation, each family returning in the appropriate year to farm its own special portion. The system is often, though wrongly, referred to as "shifting cultivation," and has even by foresters been called after the system of temporary mountain clearings in Burma as "Taung-ya" system, which it certainly is not. It is best described as "bush-fallowing," a period of cultivation being followed

by a long period of fallow, the only difference from the fallows of temperate lands being that the forest trees form the "weeds" of the fallows. Seven to ten years (during which the trees grow to 30 feet in height) may be regarded as the normal period of fallow, it is when the pressure on the land is such that the fallow period has to be reduced even to as little as two years that the system breaks down. When the time comes the fallow is cleared by burning—better if the burning is as early as possible after the rains so that the fires are not so fierce as to destroy the valued oil palms or completely to destroy the vitality of the stumps left in the ground.

Southern Nigeria is mainly tsetse infested: cattle are entirely absent over large areas and cultivation is entirely by hand—by the hoe. A family can cultivate two or three acres in this way and produce an adequate supply of the staple food—yams—together with limited quantities of cassava (manioc), corn (maize) and a supply of vegetables in the little garden plot (permanently cultivated) round the hut itself. Thus at any given time the village tract appears to be a series of tiny patches of cultivation in the midst of ragged, untidy second-growth forest of varied age. The patches themselves are a series of mounds or of yam hills (in which the yams or cassava are planted), a few stalks of maize or a few beans or gourds growing in the intervening hollows, and stumps of trees still remaining. Weeds are by no means absent, but the soil is protected. If some of the finer fractions are washed out, they are held up by the neighbouring tract of woodland. If Western ideals of ploughing, extensive clearing, weeding and single cropping were introduced, the soil would immediately be subject to serious erosion from which it is at the moment free. The Agricultural Department in Nigeria has rightly recognized this, and is concentrating its attention on the improvement of the present system by green manuring (by leguminous crops) to replace *part* of the fallow, early burning to prevent serious destruction by fire, and the improvement in quality and yield of the crops grown—especially those which may serve as additional cash crops (citrus, cocoa, oil palm, cotton, kola nuts, etc.) and supply the African with the money he needs for taxes, bicycles, travelling, clothing and the various demands coincident with an increased standard of living.

Northern Nigeria consists of large emirates in which the Emir holds the land in trust for his people. The cultivators are his

tenants, though often holding the land indirectly through the district headman. The rainfall ranges from about 25 inches along the northern border to 60 inches in the south, and comes essentially in the wet season from April until October. It falls generally in a succession of storms, four inches in a single night being by no means unusual, and in consequence the predominantly light sandy soils are particularly liable to both sheet and gully erosion. In the dry season the country is parched and bare, and liable, at least in the north, to considerable wind erosion from the dust-laden Harmattan, though the film of fine dust which this wind from the Sahara deposits is not without its value to the soil. The population of the Northern Provinces is irregularly distributed—largely influenced by water-supply, with the result that the Geological Survey is at present very actively engaged in well-siting and well-sinking. There is still a sharp distinction between the nomadic and semi-nomadic cattle-rearing Fulani and the settled Hausa cultivators, though the latter are not blind to the value of manure and may even hire the large white-humped zebu cattle from the Fulani for the sake of their droppings.

The natural vegetation of the Northern Provinces is an open savannah forest with an undergrowth of grass, merging northwards into *Acacia* scrub woodland. Uncontrolled grazing by cattle and the large northern goat results in an uneconomic use of land, of which there would be ample for normal cultivation on the same basis as in the south. Hence it is, very rightly, the policy of the Agricultural Department to introduce and popularise by means of a series of demonstration farms a system of mixed farming, and to fuse the diverse interests in the lands of the Fulani and Hausas. The results are gratifying. In 1928 three farmers tried the experiment; by the end of 1934 the number had increased to 298, but in the next year it had leapt to 621. The staple food-crops of the north are the tall guinea-corn (with stalks valued for roofing and light fencing), other millets (with a less valuable straw), together with some maize, cassava, and a few yams and, locally, rice. The staple cash crops are groundnuts and cotton. The traditional agricultural implement is the hoe, by which a family cultivates about three acres. The Agricultural Department has introduced a light plough throwing up a ridge on either side and which is to be drawn by the cattle now to be kept penned with millet straw bedding (making a manure with binding

qualities on the light soils). The donkeys and goats, so universal in the north, are similarly to be penned and manure prepared in the same way. On this system a family can easily farm twelve acres.

A visit to the experimental farm near Kano, which fortunately took place after nearly four inches of rain had fallen during the night, convinced me that the introduction of the plough into the light land of Northern Nigeria is liable to prove a curse which will more than outweigh the blessing conferred by mixed farming. Every furrow is a watercourse taking off the needed water, every one an incipient erosion gully. Cross-ploughing at intervals is not a remedy —a new gully is formed—nor is contour-ploughing in this gently undulating plain land sufficient.

Fortunately the local cultivator has already evolved a system which points the way. Instead of the yam hills of the south are ridges (from three to six feet apart and from nine inches to thirty inches high) crossed at intervals by ridges at right angles. Instead of the long straight plough-furrow the result is a series of isolated basins. Into these are swept the finer particles of soil during a storm but no soil is lost, for the basins fill with water, which later seeps away. Only rarely does a ridge give way, and even so it is easily repaired. When the land is prepared for the next year's crop the new ridge takes the place of the previous hollow, so that the soil is well mixed again. The same result can be achieved by ploughing, if the plough is lifted at intervals. This can readily be done with the light plough used. It is clear that the careful use of cover crops (a dirty farm is probably better than a well-weeded one), the restoration of fertility by leguminous crops, and the maintenance of wind breaks or "protection forests" (the Forestry Department in conjunction with the French authorities are to preserve the remaining tracts of scrub and woodland along the international border) are all necessary in addition, as well as the control of areas where erosion is already serious.

If America could invent a plough which will imitate the Nigerian system by replacing the long furrow by a series of isolated elongated basins, one at least of her major problems in the dry lands of the Middle West might be solved. (The text-figures have not been reproduced—Ed.)—(*Nature, 12th February* 1938.)

ANNUAL PRIZE-GIVING AT THE BALAGHAT FOREST SCHOOL, C. P., 4TH NOVEMBER 1937

The following important speeches were delivered on the occasion:

The Chief Conservator, Mr. C. E. C. Cox, I.F.S., made the following speech:

"Your Excellency, Lady Gowan, Mr. Mehta, Ladies and Gentlemen and students of the Balaghat Forest School—

Before telling you something about this School and its objects, I have two pleasant duties to perform.

Firstly on behalf of the whole Forest Department of these provinces I wish to thank Your Excellency and Lady Gowan and also the Hon'ble Mr. Mehta for the trouble you have taken in visiting the school to-day for the annual prize-giving. Never since the school was opened thirty years ago has it been honoured by a visit from any member of Government, still less by the Governor in person, and I am unable to express adequately the thanks of the department or give an idea of the tremendous encouragement that such a visit gives to all connected with the school. I have every hope that we may take full advantage of this long hoped for visit and be able to show Your Excellency, and Mr. Mehta, what we have done in the past and can do in the future in the direction of educating the staff of the department.

2. Secondly, I wish to thank Your Excellency on behalf of the school itself for your generosity and sportsmanship in presenting the school with such a handsome Shield. This will be known as the Governor's Shield and will be competed for annually and held by the best all round student of the year. Needless to say the possession of such a Shield by the school will provide an additional incentive to effort, both in the lecture room and in the field, and I know I am right in saying that no one realizes better than Your Excellency the importance of physical fitness and regular excersise as a means of ensuring success in life. On behalf of the school I can assure Your Excellency that your personal example of hard work combined with physical fitness will be perpetuated at this school by the Shield, which you have so kindly presented.

3. I now propose to make a few remarks about the origin and object of this school, which may be of general interest.

The Balaghat Vernacular Forest School, as it was originally called, was opened in 1907 with the main object of meeting a long-felt want and giving some sort of practical training to selected Forest Guards and Foresters who up to that time were entirely untrained and I believe I am correct in saying that it was one of the first institutions for vocational training opened in these provinces. The school opened in the first year with a class of 20 students only, but in a very short time a demand for training men from Zamindaris and States arose so that by 1914 it was found necessary to increase the number of students to 50 a year, at which figure it stands to-day. With two breaks of two years in 1918 and three years in 1931, the school has completed 26 annual courses and trained a total number of over 800 candidates, of whom 600 have been Government students. In addition to these, 43 students were admitted in various years but failed.

Though the school remains essentially a vernacular school, all lectures and text books being in Hindi, the standard of teaching has been gradually raised and the training given has been so much appreciated that practically all students are now English knowing and many of them are matriculates. For instance, of the outgoing class of 46 students, no less than 25 are matriculates and 2 Hindi knowing only. For this general improvement in the school and the raising of the standard of instruction, we are indebted to a succession of energetic Directors, Messrs. Carr, Watts, Takle, Hopkins and Maitland, and the untiring efforts of the Chief Instructor Rao Sahib Laxman Rao Lokre.

The special features of the training given may be said to be threefold: firstly, its essentially practical nature; secondly, the combination of hard work with a course of up-to-date physical training, and, thirdly, its comparative cheapness which is an important point these days.

As regards practical training, it may be said that as far as possible, classroom work and lecturing is reduced to a minimum and practical instruction is given in all subjects, for instance, apart from practical forest work, the students construct buildings, roads and bridges, making the necessary bricks, lime, mortar and wood-work of such works themselves. They also maintain and repair all the school buildings, this work having been taken over from the

Public Works Department two years ago and a considerable saving in expenditure effected thereby.

For the up-to-date system of physical training, the school is indebted to Colonels Cole-Hamilton and Brunskil and other Officers Commanding at Kamptee, who from time to time have permitted our physical training instructor to undergo the most up-to-date course of army physical training. The benefit of such training cannot be overestimated and all credit is due to Ranger Prithi Chand, who has been physical training instructor for many years, for the high standard of efficiency he has maintained and also to Ranger I. N. Dube, who underwent a course of training at Kamptee this year and is mainly responsible for the efficiency seen in the present class.

As regards the cost of training, the school is run on economical lines with the Divisional Forest Officer as *ex officio* Director, and an officer of the Central Provinces Forest Service as Chief Instructor, the latter being assisted by three selected Rangers. The present cost of one year's training per student amounts to Rs. 700 as compared with Rs. 2,200 per student for the same period at Dehra Dun.

4. Now, though the general nature and standard of training given at the school may be said to be satisfactory it yet suffers from certain defects, the chief one being, if I may put it so bluntly, that until to-day the school has never been visited by any member of Government or received the encouragement and financial assistance it deserves. There is, I know, a general feeling amongst those who have been associated with its administration that its organization is not made full use of and that the school is capable of doing more both for the department and Government. I share this opinion. The main point is, I think, that the period of training *viz.,* one year, is too short and under existing circumstances we try to cram into this short period too much teaching with the result that just when students are beginning to become useful practical foresters and physically fit, they have to leave the school.

Depending on whether a policy of provincialization and economy is insisted upon, I think it is a matter for consideration whether the school could not, by extending the period of training, be made capable of efficiently training at least the honours men for the

Ranger's grade at very much less cost to Government than if they were sent for the two years training at Dehra Dun, though I do not in any way claim that the standard of such training can compare with that of Dehra.

We are fortunate in having as our Minister a broadminded gentleman who, in addition to being a personal friend of many of us, is himself interested in the work of the department and its needs, and is also anxious to examine all aspects of its administration. I have no doubt that the future development of this school will receive his full consideration and that under his guidance it may be expected to play a much more important role in the future organization of the forest service of these provinces than it has done up to date.

I must again express my thanks to Your Excellency and Mr. Mehta for visiting the school to-day and seeing for yourselves whether these views have any justification.

5. I now wish to address a few words to the students. Firstly, to you outgoing students who have completed your training and are about to return to your divisions.

I know quite well that some of you are pleased at your success in obtaining Honours or a Higher Standard pass, others are equally disappointed at only obtaining a Lower Standard pass. I want to tell you all that whether you have passed by the Higher or Lower Standard matters not at all as regards your future success. What really matters is your own individual efforts to apply what you have learnt at this school when you return to your division. I want you to remember that by passing from this school, whether it be by the Higher or Lower Standard, the door is open to you to promotion, but if you want this promotion you must keep up in your future life what you have learnt at this school apart from books and lectures. By this I mean the four essentials to success, *viz.*, hard work, honesty, discipline and physical fitness. If you stick to these principles, I feel sure your success is assured. In proof of what I have just said I can tell you that at the present time out of a total of 125 ranges in the Province no less than 45, or very nearly one-third, are held by Balaghat trained men, and of these 45 ranges 36 are held by Higher Standard pass men and 9 by Lower Standard pass men. It, therefore, now rests entirely with you to show what you can do. This

school has done its best for you and I can only wish you all the best of luck and success in your future careers.

6. To the new class of incoming students the best advice I can give is to remember that you have all been specially selected for training here and, therefore, you should make the very best of your opportunities. You only have one year. During this one year a great deal will be taught you and you will be made to work hard, but on this one year's work may depend your future success in life. If you want this I can only suggest that you all try and win the Shield which His Excellency the Governor has so generously presented to you."

The Hon'ble Mr. D. K. Mehta, Minister for Finance and Forests, then rose and made an eloquent speech in Hindi, the substance of which was:

"Your Excellency Sir Hyde and Lady Gowan, Mr. and Mrs. Cox, brother workers in the Forest Department, Ladies and Gentlemen—

When the Chief Conservator of Forests invited me to attend this function I accepted the invitation with a little avidity, for I felt that as Minister for Forests it was my duty to place myself in touch with the high and low in my department. No better opportunity could be offered to me to meet the students in a body—particularly those who were on the point of going back to their division after their training. I should have missed them if I had not torn myself away from my family with whom I should normally have been for this great Divali festival.

I thank your Excellency for having paid this visit and you Mr. Cox for the flattering terms in which you have referred to me. I am particularly glad that in Mr. Maitland as Director of this Institution I have a very old friend of mine.

I was delighted to learn that the doctrine of dignity of labour finds the most important place in your curriculum. You make your own bricks and lime to build the quarters which house you. This reminds me of the Tuskegee Institute of Alabama where the Negro boys built their own buildings for their University. What pleased me most was the stress laid on physical culture. Whatever be true in other walks of life, in this vocation of yours physical fitness is essential to enable you to discharge your duties efficiently. The

ravages of disease which find nourishment in the bad climatic conditions of some parts of our forests require you to build up a robust constitution which will stand the devastating attacks of these pests.

I have taken note of the different grievances mentioned by Mr. Cox in his speech. I do hold that if government compels its servants to live in quarters provided by it they must be decent enough for human beings to dwell in. Two or three years ago I saw them when I happened to go round with a friend of mine. I found that they were not much better than stables. I am certain we shall be able to set them in order. Similarly I appreciate that the time during which you are supposed to imbibe all that is laid down in your curriculum is proportionately too small and should be extended.

One last word which is of the utmost importance. I wish to assure you that I am speaking to you as one of you and not as an outsider. It is unfortunate that in this department the lower grade of officials should have earned a bad name not only with the non-official world but also with officials of other departments. This is a stigma which we must wipe out and in this I look forward to you students to give me your full co-operation and support. A blemish on you, I take as a blemish on those who hold the reins of government. By the grace of God I have been placed at the head of this department and I shall devise means to put things right. This is neither the time nor place to say what I intend doing but I wish to make here and now this fervent appeal to you that you, with whom more than with many other service, the police and revenue officials included, people come into the closest contact will make every effort to remove this unfortunate impression which has gathered round your name.

I once again thank you all for this opportunity which was afforded to me to address you."

Finally, His Excellency Sir Hyde Gowan, K.C.S.I., C.I.E., V.D., I.C.S., Governor, Central Provinces and Berar, spoke as follows:

"Mr. Cox, and students of the Balaghat Forest School,—

My wife and I thank you all most sincerely for the invitation which you have given us to attend your annual prize-giving and for the cordial welcome which you have extended to us to-day. When Mr. Bell suggested to me some months ago that I should pay this visit, and told me that my doing so would be a great encouragement

to the school, I agreed without any hesitation, and I did so for a very particular reason—a reason which is founded partly on the experience of 35 years of service in this country, and partly on the lessons which those who run may read in the recent history of certain other countries.

The forests of this country, and the forests with which so large an area of this province is covered, are a priceless heritage—a heritage which it takes years, generations, centuries even, to bring to maturity, but which can be destroyed almost in a night. No one who has read the history of the recent droughts in America, or such books as Professor Huxley's "Africa View" can fail to picture the appalling disasters to humanity which may result from forest denudation, or to realize that a people which gives in weakly to the clamour for such measures as free grazing and the relaxation of forest control barters its heritage for a mess of pottage. You who are the students of this school will go forth to be the guardians of that heritage. It will be yours to see that the trust which is placed in you is fulfilled; that, while everything is done to see that the people of the villages have the proper use of the forests, nothing is done which may damage them permanently or decrease their capital value.

And in the performance of that task I would ask you to remember one thing. Power will be put into your hands, and the temptation will come to you to abuse that power. That temptation you must resist at all costs; for there is nothing that will bring greater credit to your department than the knowledge that its officers, from the highest to the very lowest, are as anxious to see that the people have the right use of their privileges as they are vigilant to protect the property of the State.

My advice to you then is: go forth and endeavour to practise in your daily life the principles which the Chief Conservator has just laid down so ably for your observance and the lessons which are taught to you during your year at this school. And may God speed you in your task."

* * *

THE MAN-MADE DESERT IN AFRICA—EROSION AND DROUGHT

BY PROFESSOR E. P. STEBBING

(*Continued from pp.* 314-323 *in May* 1938 *number*)

6. DESICCATION

A much-debated term. It is held to be primarily due to the over-utilisation of the vegetative covering of the soil, under which productivity is reduced, water supplies decrease in the springs, streams, rivers and wells, the water table sinks in the soil strata and the rainfall decreases. May be due to (*a*) erosion in varying forms through the over-utilisation of the soil; (*b*) presence of neighbouring deserts and sand penetration; (*c*) a combination of (*a*) and (*b*), accompanied usually by dry, hot, or cold winds.

Lavauden (*Les Forêts du Sahara*) does not use the word "climate" in connection with this process which he terms *déssèchement*, meaning only the progressive diminution of surface and subterranean water supplies. He does not discuss the relations existing between disafforestation and desiccation. His reason being, he says, that Foresters have not formed definite conclusions. He is here obviously expressing the opinions of European Continental Foresters—based on experiences in temperate climates. I think Lavauden made a mistake in passing over this important factor. It appears certain that had he had a longer practical experience of forestry in connection with erosion in other tropical and sub-tropical countries he would have expressed himself more decisively on the subject.

Kennedy Shaw, in considering this matter for Southern Libya (*Geog. Jour.*, Vol. 87, March 1936), says it "is one of the present day increase of desert conditions due entirely or largely to the acts of man."

In Northern Nigeria desiccation, to whatever agency or series of agencies it may be relegated, is an accepted fact. Here it may, it is suggested, be attributed to a combination of erosion ***sur place*** (on the level country) coupled with the lowering of the water table in the soil, falling off of the rainfall, and sand penetration.

In some parts of Africa desiccation, aided by sand penetration, may be due in part to blown sand from drying-off river banks or shores of diminishing lakes (Champion *loc. cit.*).

7. SOIL DENUDATION OR GULLY EROSION

The clear felling of forest in hilly and mountainous regions is quickly followed, under the action of rain and heat, by soil denudation, often accompanied by the formation, *i.e.*, the cutting out, of gullies in the slopes which on occasion may develop into regions of spetacular form. It is this type of erosion which gives rise to flooding, sometimes on a titanic scale, as was apparently the case in parts of Africa in olden times, *e.g.*, the floods from the Atlas Mountains pouring down through the great Wadi Saoura in the Sahara; or as experienced in parts of India, and perhaps in modern times more especially exemplified in the United States by the gigantic rise in levels and flooding of the Ohio and Mississippi rivers in the winter (January, February), 1937.

Under this method of erosion the soil layers are removed by the action of water, apart from the amounts of the dried-up humus layer which once exposed disintegrates rapidly and is blown away in the form of dust. The greater proportion of the soil particles carried away by water fill the streams and rivers until they run in muddied torrents. With the intensification of the denudation and gully formation the rainfall water, with nothing to retain it, runs at once down the slope into the nearest stream, with the consequence that heavy rainfall results in a volume of water pouring rapidly into stream and river beds beyond the capacity of the latter to retain, and floods are the result, which, owing to the rapid run off, may appear with a calamitous suddenness.

The large amounts of silt, consisting at first of the rich productive soil layers, thus carried into the streams and rivers, results in the beds silting up. In the hot months, with the drying-up of the hill springs and lessening of the water in the tributary streams, the latter run dry or the water is restricted to interrupted pools, and the water in the larger rivers is confined to a small part of the bed only. The rest of the bed may be naked rock or is occupied by great banks of sand or mud, or a mixture of the two, the surface of which dries off into fine particles and may be blown away in dust clouds. Or the river beds may become filled with banks of pebbles and great boulders.

Besides the contraction in volume and depth of the water as a result of this denudation, bars are formed at the mouths of the

rivers by the deposition of the silt carried in suspension in the rapid-flowing water and checked when the current meets the sea barrier, thus reducing the usefulness of harbour and river for transport purposes.

With the increased denudation, and extension of the width of the gullies, large amounts of rouble and boulders of increasing size sweep down the slope, covering up valuable agricultural land below.

Perhaps one of the best-known often-quoted examples of this type of damage is the case of the Hoshiarpur Chos in the Punjab, India. This part of the Siwalik range of hills consists of friable rock. The hills were formerly covered with forest. In the latter part of last century, cattle owners settled in the area, and under the grazing and browsing of buffaloes, cows, sheep, and goats, all vegetative growth disappeared and the trampling of the animals on the slopes loosened the already loose soil. Heat and the annual monsoon rains helped to carry on the process of erosion commenced by the animals. Gradually, ravines and torrents were formed which have cut the hill range into a series of vertical hollows and ridges of the most bizarre shapes; the material thus removed and carried down to the lower level forming fan-shaped accumulations of sand extending for miles out into the plains country, covering up extensive areas of valuable agricultural land. The loss has been enormous, but for years the Government hesitated to intervene. Some most difficult reafforestation work is now being undertaken in this region.

Another example may be quoted indicating what protection can do. On the same range of hills, to the east, in the region of the Dehra Dun plateau, the forest had been ruthlessly exploited for timber and further damaged by unchecked pasturage and the more or less annual fires which ran over the hills. Erosion had started apace before the Forest Department took the area over and introduced protection from grazing and fire in about 1876.

At the close of the century the Inspector-General of Forests was able to show a Member of the Government of India the remarkable results which had ensued. Many eroded stream-channels surveyed in 1876 have ceased to exist, being overgrown with young trees and bushes. In the case of the Ratamau basin, the sides and slopes of the hills were clothed with grass and young seedlings, and the water no longer rushed down carrying silt with it; the floods in the streams

had, as a result, become reduced in volume, the water channels had become narrower and deeper, and the old beds were overgrown with grass and thousands of sissu (*Dalbergia sissoo*) and khair (*Acacia catechu*) seedlings. The little silt washed down was caught by the grass tufts, resulting in the elevation of the banks in the stream's bed and the deepening and constricting of the water channels.

A third example from India is perhaps even more applicable to parts of Africa. There is a great tract of waste land along the Jumna and Chambal rivers in the Etawah, Agra, Jalaun, and neighbouring districts in the United Provinces, stretching over some million acres. There are miles of appalling destitute, hot, and lifeless ravine country, the ravines eaten out of the level country under the heavy monsoon rains. Much of this country was once fertile, its present condition being due to ignorant disafforestation in far-off times at the head waters of the Jumna river and its seventeen tributaries. At the present day the forest areas on many of these rivers are altogether inadequate to prevent further denudation by sudden flooding, and so forth; and are often far too heavily grazed. So far as the Jumna is concerned, the accumulated effect of this flooding and scouring has resulted in its bed at Etawah being lowered 60 feet in the last 500 years. It has been stated that the cold weather level of the Jumna in the Etawah and Jalaun districts is often 120 to 200 feet below the general level of the surrounding country. The sinking of the bed of the river was draining the country, and the water levels of wells were sometimes as low as 200 feet. The banks of the rivers in the three districts above mentioned were now so completely drained that they had become destitute of all vegetation save a desert flora, and even that was disappearing. This dry belt was increasing at the rate of 250 acres each year in the Etawah district alone. The complicated network of ravines already alluded to had been formed owing to the absence of protective vegetation on the banks and the flow of water from the high plateau into the river.

Reafforestation was started by the Forest Department in 1912 and some of the work accomplished shows that some areas of this degraded type can be successfully brought back to an economic use.

The well-known erosion damage in the outer Punjab hills and its danger to the great network of canals which have in recent years turned the barren Punjab plains into great wheat fields, furnish

another evidence of the ignorant treatment of important forest areas, owing to the disinclination to interfere with the improvident habits of the people.

All the above examples I have been able to study for myself. A proportion of the coffee, etc., plantations in Madras and Ceylon (already alluded to) and of the cocoa in the Gold Coast come under this type of erosion.

It is recognised that the gigantic floods on the Mississippi and Ohio rivers in the early months of 1917 were the gradually accumulative outcome of the great disafforestation which had taken place in the catchment areas of these two rivers (in the case of the Missisippi to the east) and their tributaries, the Ohio river itself joining with the Mississippi at Cairo (Illinois).

On the eastern slopes of the Udi plateau in the south-east of Nigeria, erosion has caused damage which is now being scientifically attacked by the Forest Department of that Colony, and some good work has been carried out on the lines of that at Etawah, India.

* * *

The divisions into which I have provisionally divided Soil Erosion are not drawn up from a text-book viewpoint. Nor do they pretend to be all-embracing. They are simply based on observations of different types investigated and studied by myself in different countries.

It is felt that some sub-division of the kind is required in order that those who are confronted with the erosion problem in the administration of a region should be able to roughly indicate the type they have to deal with, and that the press, whose support in this difficult matter will prove invaluable, should be able to roughly differentiate between the different types and to some extent their origins.

The end of all erosion if carried to its logical outcome is a barren land or desert; the routes by which this end is achieved may have, at the start, very different beginnings. It has been shown, for instance, that erosion, commenced as one of the types, may be carried to its final stage of unproductive land or desert by one of the other subdivisions. For instance, a common example in parts of Africa, agricultural crops replaced by stock when the vegetative covering and soil are no longer sufficiently productive to grow crops, for whatever purpose the latter are raised.

DROUGHT AND THE INTERMITTENT STAGE IN WATER SUPPLIES

What is Drought?

When, in the summer of 1936, descriptions of the terrible state of affairs taking place in what is termed the Dust Bowl in the Western districts of the United States appeared in the press, I ventured to query* the use of the word "drought" in connection with the drying-up of water supplies and the falling off in the rainfall.

An ordinary definition of "drought" in the English language would refer to months of dryness at periods when the ordinary average rainfall is received. For Europe, so far as records go, there appear to be years of wetter months followed by years of drier ones, and we speak of drought in its true sense—climatic changes, in other words, over which man can have little or no control.

Can the word be equally applied, or applied with its true significance, to the upsetting by man of Nature's balance between the soil and its covering and the water supplies? With the resulting dislocation in the regular average water supplies received in rainfall and from the springs, streams, rivers, and wells of the region!

So far we have knowledge of the results attendant upon this intervention of man in Nature's balance it is becoming more and more evident that periods of drought will not be followed by wet periods, as has been sanguinely hoped in some quarters in connection with the major catastrophies facing man in certain parts of the world. Such hopes, it is to be feared, are illusive.

A study of this question would appear to resolve itself into the following proposition.

As a result of erosion in one of its forms owing to the improvident utilisation of the soil and its vegetative covering by man, water supplies have decreased—either moisture in the upper layers of the soil, owing to the lowering of the water table, thereby affecting wells; decrease in, or cessation of, springs; disappearance of the water in streams during the dry months of the year and lowering of the level of the water during the same period in the smaller and larger rivers. The rainfall has also decreased in annual amounts, though the amounts of such decrease may be slower in making their appearance; but, more alarming, this rainfall has become capriciously intermittent

*_The Times_, 4th September, 1936.

in its supplies—no man being able to forecast the amounts which will be obtained within the year; or often, within limits, at what periods!

This is not "drought" in the ordinary accepted sense of that word. I would term it the Intermittent Stage in rainfall supplies.

It may be suggested that if the fact of the intermittency of the rainfall, developing at a certain stage in the degradation of the soil and its covering, be accepted as a factor of importance in this decrease in fertility, we can start from a point at which we are all voicing the same position of affairs and can commence, according to the different types of erosion, the business of combating this danger.

It may be asked, "How can this stage be recognised on the ground?" Examples are only too plentiful.

If we examine the regions bordering the southern edge of the Western Sahara, British and French Colonies, it will be found that a stage is reached in the rainfall when dependence upon it for crop production can no longer be placed with ordinary confidence.

A typical example can be studied in certain localities in Northern Nigeria and the French Niger Colony. The local population complain of violent winds which, blowing at the beginning of the rainy season about May or June, bring blown sand on to the fields. But even these winds are not consistent, for in Damergou the worst winds from their point of view blow in December and January. But the Chiefs of these areas are at one upon the main point. The millet crop is sown during the first rains. Should the previously normal second rains arrive up to time, when the seedlings have shown above ground, the roots of the latter fix the sandy soil (it will be noted that there is already a sandy covering to the normal soil surface of the locality) and the growth of the crop proceeds successfully. Should the second rains not come up to time, however, sand carried by the strong winds covers the small shooting seedlings and kills them. The operation of sowing has then to be undertaken a second time, and on occasions even a third or fourth time. It is said, though to a farmer with a knowledge of his job the statement will appear an incredible one, that in certain years it is necessary to re-sow the seed as many as ten times!

This example would appear to be a strong argument in favour of the postulate here advocated that a time arrives when the rainfall

becomes intermittent, and man can count no further upon its reliability.

What is the inevitable result?

The stock keeper takes the place of the crop grower. The scrub forest or bush is still there and gives subsistence to the animals. The region is not beyond man's power of saving. It is in that delicate stage of oscillation in water supplies and rainfall which has been brought about by over-utilisation of the soil by primitive methods of cultivation; but the delicate balance is about to swing, has already commenced a slight downward swing, on the wrong side of what is here termed the Intermittent Stage in rainfall supplies. Every step beyond this point, and by going north into the desert the stages can be studied, is a pace in further degradation: until a stage is reached—a stage which is prior to the ultimate desert—at which no action of man, even if backed by unlimited capital, can prevent the final catastrophe.

For present-day practical purposes, therefore, it is suggested that this intermittent stage, the stage when the danger can be arrested and the original conditions so far as water supplies and so forth be restored, can be recognised on the ground under all the different types of erosion.

Consider, for example, the line of country in Northern Nigeria proceeding from Geidam on the east, with its desert-appearing conditions, west on to Kano, with its rich cultivation, and further west to Katsina, with its stages of desiccation.

Geidam I should place in that oscillating intermittent stage when the balance is just dropping on the wrong side. The Kano agricultural lands are a delight to see; for how long they will remain in this position when the conditions of the regions to the north-east, north and north-west are taken into account it is not possible to say. My observations in Katsina would lead me to infer that the tracts in the southern parts are at the top of the oscillation, whereas for those to the north the balance is dropping on the wrong side and is reaching that debatable point, with other areas in the region, where man must be very nearly reaching his last chance of undertaking rehabilitation.

A good illustration of this latter position can be seen in the Lema Forest Reserve in the Argungu Division of Sokoto, due west of Katsina.

About 1931 there was a threat of famine due to locusts. The people residing in enclaves in the forest (the latter consisting of Baobab, ***Anogeissus, Acacia,*** **etc.) appealed for a new area for farms on the** plea that their land was unsuitable or worn out. Some 600 acres of forest were felled, an area far larger than their requirements, with the idea of taking advantage of the high prices famine would bring about. The locust invasion did not arrive and no famine arose. Much of the disforested land was never cultivated and has since become a complete waste of drifting sandy soil now incapable of cultivation, on which a first attempt of the Forest Department to reafforest has failed, *owing to the desert conditions becoming so rapidly established after the disforestation.*

The above remarks and examples are not made with any idea of a nice exactness, but are merely given as an indication of what is meant by the stage which I term Intermittent Rainfall. Local officers should be able readily to assess the position with greater exactitude.

Another example—Champion's description (*loc. cit.*) of the erosion taking place in the Province of Turkana, west and south-west of Lake Rudolph in Kenya, of which extracts were reproduced in my *Threat of the Sahara.* It would not be difficult to mark down the parts of that region which were in the Intermittent Stage from those which had got beyond it.

I have quoted (*The Threat of Sahara,* p. 20) Gillman and his studies of erosion in Tanganyika. Other examples could be given for Uganda and Nyassaland.

Again, Mrs. Huxley (*The Times,* June 10th and 11th, 1937) graphically described areas in the Wakamba Reserve in Kenya as so over-grazed as to have become practically desert. From her descriptions I should be inclined to say that these areas, or parts of them, have got beyond the Intermittent Stage. Basutoland is another case in point. Also considerable tracts in the South African Dominion.

I hold the opinion that the expert, and in this category I include the district and political officer with a local knowledge of the region, should not have much difficulty in practically assessing his region and, for protective and ameliorative working purposes, earmarking those areas which fall within this Intermittent Stage of the rainfall supplies.

It has become apparent that in some quarters opinions are held that there can be no analogies between, say, the desiccation being produced in parts of Africa and the conditions under which the Dust

Bowls have arisen in America or the soil drift taking place in Southern Australia. If, however, we trace all categories of erosion back to their origin or commencement I think it will be possible to show in every case that in this over-utilisation of the resources available, with the consequent upsetting of Nature's balance, a stage was, with few exceptions always reached at which that factor which governs all production and life, the water supplies, commenced to become intermittent. One way or the other this stage must have made its appearance.

Under excessive utilisation of the soil then the rainfall supplies in the region fall into a delicate state of oscillation. It has been mentioned above that the first noticeable (to man) decreases in the local water supplies will show themselves in a lowering of the water table in the soil owing to the decrease in water in springs or their drying up, the drying up of streams in the hot months of the year, and lowering of the water levels in the rivers. These precede the falling off in the rainfall supplies. The trouble which has taken place in the past in recognising this latter factor is due to the fact that man's life is short, his period of active service as an official shorter still, whilst the results due to an interference with Nature's balance may be very slow and almost if not quite, imperceptible over a period of years. Consider, for example, the slow stages in the formation of the Sahara! Consequently, the Intermittent Stage in the rainfall supplies may have been prolonged for very long periods before the balance delicately dropped on the wrong side.

This in the past!

Can the same state of affairs be said to exist at the present day?

Many parts of Africa, with their increasing populations and flocks and the accelerated over-utilisation of the soil, are witnesses to the contrary—witnesses to the alarming fact that this accelerated over-utilisation is producing a state of affairs which no amount of education or other palliatives will be likely to arrest in time. The world has been shocked at the appalling conditions which have been produced in the Dust Bowls of the United States and Canada, where whole populations have been migrating, within a brief period of years; a period which, in contrast to the slow extension of the Sahara, is but a grain of sand by comparison.

The danger is cumulative.

Whether on the southern edge of the Sahara, where sand

penetration assists desiccation; in level country at the foot of rapidly-eroding hill ranges; on the periphery of the Dust Bowls in America and Canada; or on the confines of the soil drift which is said to be forming the desert in Australia, the danger to the neighbouring agricultural or pastoral country is the same—the extension of the existing destroyed regions on their boundaries owing to the over soil utilisation and the drying up of water supplies and cessation of rainfall in their neighbourhood. It is in these regions that the Intermittent rainfall stage has been reached and man is called upon to make his effort to restore the balance of aforetime before it is too late.

It is a natural query: At what accelerated pace, compared with the past, are the processes of degradation—erosion, desiccation, sand penetration, the term adopted varies with the conditions being produced—proceeding in Africa? What have the last 50 years shown?

Suggestions for Dealing with the Existing Position in Africa

After considerable reflection I am unable to consider it an over-statement that many parts of the Africa of to-day, under both British and French rule, are in a very serious position, a position which is primarily due to erosion in one of its forms. I have heard it stated that too much is being made of the Sahara question and the desiccation resulting from the present form of soil utilisation. Also that the erosion question is being too loudly ventilated. It is in the belief that when the word erosion is used its actual meaning in a particular case is not always entirely comprehended that this paper has been written.

The answer to those who are sceptical on the subject of either the Sahara danger (a very old one, now becoming more formidable) or one or other forms of erosion is simple. The case for both Sahara and other forms of erosion has been plainly stated. It would be a relief to find proof being brought forward to establish the fact that the position had indeed been over-stated and that the danger was far less than the object lessons on the ground bear witness to.

It is held that the serious erosion is due to the methods of utilising the land. These methods are supported, because permitted, by the Administration. Neither agriculturist nor forester, nor indeed any of the other Services connected with the land, can do more

than draw attention to the increasing and accumulating dangers arising from the habits of the people, including the deplorable one of firing the countryside annually, and advise as to the necessary steps which, in their opinion, should be taken.

It is for the Administration to act. The political reasons which have led to the present dangerous position are perfectly well understood and need not be entered into here. But since expert opinion which, it is understood, includes not a few political officers themselves, recognises that the present agricultural method of the people are detrimental to the maintenance of soil fertility and water supplies in certain parts of Africa, the first and primary step of importance must come from the Administration. Commissions and Committees and the reports of experts are useless until the Administration has reached the conclusion that soil deterioration is taking place over large tracts, and that the reason of such deterioration is the present methods of over-utilisation of the soil.

It has been said in some quarters that the education, now being so liberally given to the African, will result in his becoming soil-conscious, and that he will become aware of the present wasteful methods of soil utilisation which have come down to him from his ancestors. Those who are acquainted with the scale upon which erosion is taking place point out that over considerable areas the danger point has been already reached; that to await the dawn of some problematic future when the educated African will take the necessary action himself is to risk either the migration (if possible) or starvation of no inconsiderable percentage of the population. Or, as a least of the dangers, a decrease in their well-being and a lessening in the amount of food production in regions which are under our administration.

From the political and administrative viewpoint, therefore, there appears to be only one question upon which a decision requires to be undertaken.

Is there any truth, and if so, how much, in the statements of experts that considerable portions of Africa are suffering more or less severely from erosion in one or other of its forms, accompanied by decreasing water supplies, and that they are in danger of becoming non-productive in a more or less near future?—(*Extracted from supplement to the "Journal of the Royal African Society" January,* 1938, Vol. XXXVII, No. CXLVI.)

(*To be continued.*)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for March 1938:

IMPORTS

ARTICLES	MONTH OF MARCH					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER Teakwood— Siam ..	..	30	5	..	4,659	592
Burma ..	..	..	17,063	..	..	21,05,170
French Indo-China	122	449	262	15,717	47,270	34,677
Other countries ..	..	203	245	..	22,574	31,872
Total ..	122	682	17,575	15,717	74,503	21,72,311
Other than Teak— Softwoods ..	833	1,528	1,476	55,858	1,00,234	1,20,983
Matchwoods ..	..	807	260	..	45,111	15,475
Unspecified (value)	..	..	..	1,06,933	16,201	1,77,987
Firewood ..	66	40	27	990	600	405
Sandalwood ..	9	57	..	1,450	12,503	..
Total value ..	..	..	..	1,65,231	1,74,649	3,14,850
Total value of Wood and Timber ..	..	..	..	1,80,948	2,49,152	24,87,161
Manufactures of Wood and Timber— Furniture and cabinetware ..	..	No data			No data	
Sleepers of wood ..	..	..	36	24	..	2,614
Plywood ..	..	362	500	..	81,557	1,18,352
Other manufactures of Wood (value) ..	..	..	..	1,91,661	1,66,738	1,81,467
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	1,91,685	2,48,295	3,02,433
Other Products of Wood and Timber— Wood pulp (cwt.) ..	15,143	19,292	36,927	98,336	1,33,818	3,42,809

EXPORTS

ARTICLES	MONTH OF MARCH					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	5,223	5,028	..	10,29,232	11,13,792	..
„ Germany ..	219	1,162	..	42,122	3,17,880	..
„ Iraq ..	127	64	44	19,827	11,261	4,198
„ Ceylon ..	284	254	..	32,458	41,942	..
„ Union of South Africa ..	807	282	4	1,70,396	63,630	447
„ Portuguese East Africa ..	238	174	..	35,178	33,125	..
„ United States of America ..	53	38	..	15,901	9,515	..
„ Other countries	822	668	351	1,03,889	1,40,296	57,496
Total ..	7,773	7,670	399	14,49,003	17,31,441	62,141
Teak keys (tons) ..	634	536	..	91,800	92,985	..
Hardwoods other than teak ..	260	363	..	26,655	36,341	..
Unspecified (value)	..	..	..	92,138	3,84,203	1,27,857
Firewood ..	2	..	5	20	..	50
Total value ..	..	..	..	2,10,613	5,13,529	1,27,907
Sandalwood—						
To United Kingdom	..	11	..	..	11,600	..
„ Japan ..	..	5	1	..	2,766	880
„ United States of America ..	50	84	..	50,000	87,400	..
„ Other countries	4	14	14	4,517	17,075	11,462
Total ..	54	114	15	54,517	1,18,841	12,342
Total value of Wood and Timber ..	..	..	..	17,14,133	23,63,811	2,02,390
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	17,538	28,886	32,674
Other Products of Wood and Timber		No data			No data	

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A ROUGH GUIDE TO THINNING TEAK BASED ON AVERAGE SPACING FOR A GIVEN MEAN DIAMETER

BY M. V. LAURIE, M.A., I.F.S.,

Silviculturist, Forest Research Institute.

The desirability for having a rough guide to thinning teak especially in irregular forests has frequently been expressed. In the case of sal in Bihar, Warren has suggested the method of thinning the trees to a distance of $1\frac{1}{2}$ times the diameter in inches converted to feet. (1)

As a matter of interest, while compiling the yield table for All-India Plantation Teak the data were studied to see whether the ratio between spacing and diameter remained fairly constant and, if so, what the relation actually is. Square spacing was considered, since it better represents the condition of a crop than triangular spacing which presupposes more perfectly regular and maximum efficiency of spacing. The curve (I) in the figure was obtained and an equation fitted to it which gave the relation:

$$S = 2.84 + 2.06d - 0.03d$$

where S equals the average spacing in feet (square) and d equals the crop diameter in inches.

Such an equation is, of course, most difficult to remember, but it is possible to draw a straight line (II) of sufficiently approximate fit for practical purposes that has the equation:

$$S = 1.5(d + 3)$$

where d is in inches and S is in feet.

The average espacement is thus obtained by adding 3 to the diameter in inches and increasing the total by half as much again.

(1) Warren, W.D.M., "Thinnings,"—"Indian Forester" December 1936, pp. 743—746.

A

In doing a stick-thinning or in conducting any thinning based on *minimum* espacement it is found that very roughly the final average espacement is about $1\frac{1}{2}$ times the minimum espacement. For instance, thinning a pole crop with a 6-foot stick will give about 9 feet average final espacement. Hence if minimum espacement is to be used as the criterion of thinning, the formula becomes:—

$$S\ (\text{min.}) = d + 3 \quad - \ - \ - \ - \quad (\text{Line III})$$

where S (min.) = minimum espacement in feet, and

d = diameter of the tree in inches.

All the Forest Guard then has to do is to add 3 to the diameter of the tree in inches and thin to the same number of feet all around it. For instance an 11″ diameter tree would be given 14′ of room and a 2-foot diameter tree 27′ of room.

This is, of course, a very rough guide to thinning, but it would be interesting if forest officers could test it out in some of the more irregular crops of teak and find out whether it gives reasonable results. The writer would be very much interested to hear if such a guide as this is found to be a help in giving subordinates a standard to work on.

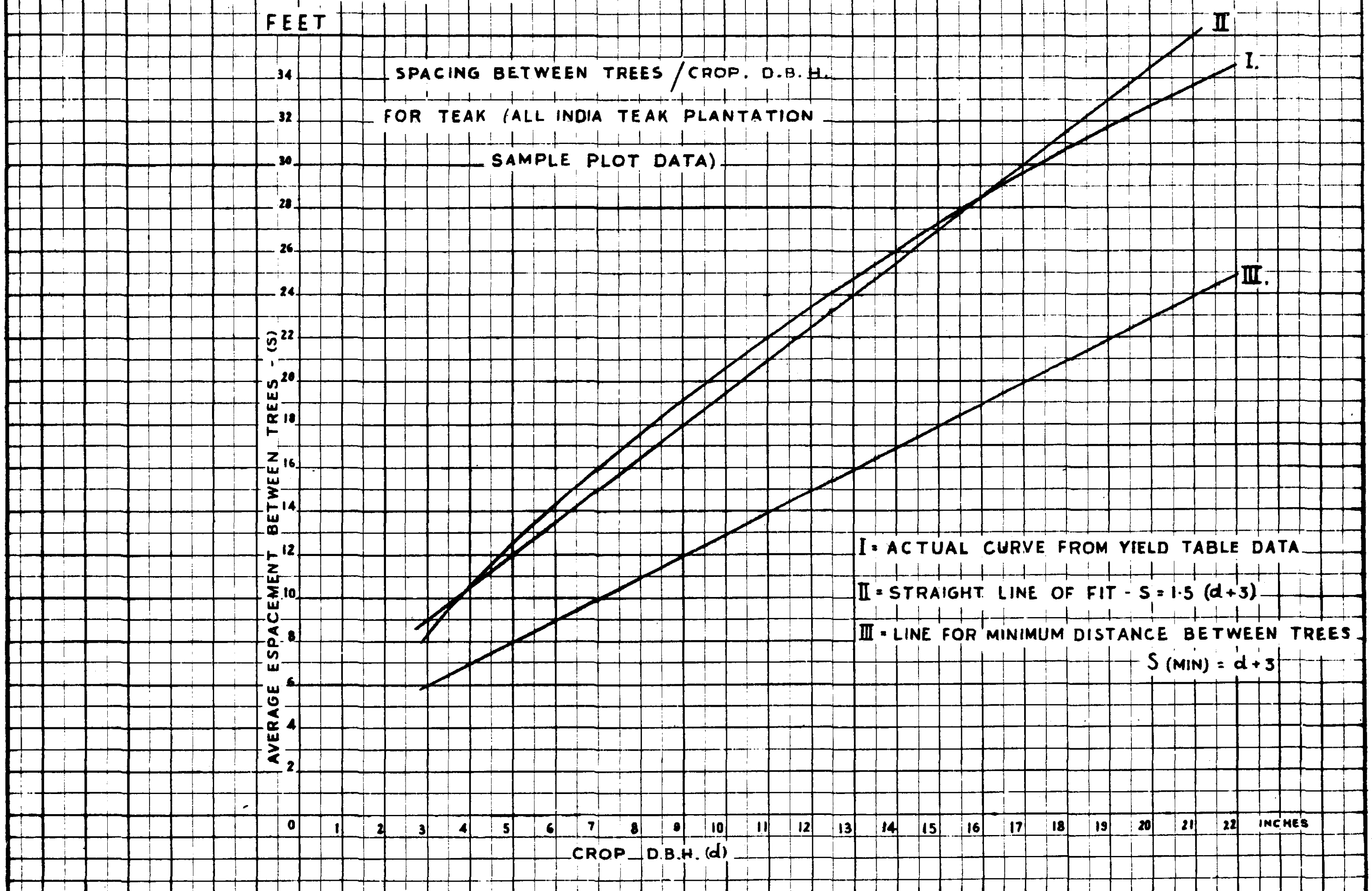
As this guide has been deduced from theoretical considerations involving considerable assumptions and approximations it should on no account be adopted on a large scale until it has been thoroughly tested out in the field to see if it gives reasonable results under local conditions.

REGENERATION OF SEMAL (*BOMBAX MALABARICUM*) FROM ROOT SUCKERS

BY M. T. HUSSAIN, I.F.S.

In the *Indian Forester* for December 1936, Mr. Holland reported on *semal* root sucker experiments in the Dhaba range of the South Chanda division. These experiments have been continued and amplified and although no definite inference can be drawn at this stage, there are good hopes of evolving a suitable regeneration technique. The various experiments are described below:—

PLATE 32


FEET
SPACING BETWEEN TREES / CROP. D.B.H.
FOR TEAK (ALL INDIA TEAK PLANTATION
SAMPLE PLOT DATA)
II
I.
III.
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
AVERAGE ESPACEMENT BETWEEN TREES - (S)
I = ACTUAL CURVE FROM YIELD TABLE DATA
II = STRAIGHT LINE OF FIT - S = 1·5 (d+3)
III = LINE FOR MINIMUM DISTANCE BETWEEN TREES
S (MIN) = d+3
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 INCHES
CROP D.B.H. (d)

EXPERIMENT I.

(*Compartment* 19, *Chionda Felling Series.*)

Two concentric trenches 1′ by 1′ were dug in April 1936 round 10 stumps of *semal* trees felled in the cold season of 1935. One trench was at 3′ from the stump and the other at 7′. All lateral roots met on trenching were cut right through.

Suckers appeared in July 1936, about a month after the commencement of rains. In August 1936, it was noticed that suckers were being browsed by *chital* and were generally straggling. Fences were therefore provided, the trenches filled in and soil tramped lightly round the suckers to give them support. By October 1936, suckers round two stumps had died, but a large number round the remaining stumps persisted, the average number per stump being 16.

On 7th January 1937, a heavy thinning was carried out amongst the suckers, only 1-3 being retained round each stump. These suckers have all persisted and the average height in March 1938 was about 5′.

EXPERIMENT II.

(*Compartment* 122, *Chionda Felling Series.*)

Three concentric but interrupted trenches 1′ by 1′ were dug round standing trees at 3′, 7′ and 11′ as follows:

(*i*) Round six trees in May 1936.
(*ii*) Round six trees in July 1936.
(*iii*) Round one tree in September 1936.
(*iv*) Round one tree in November 1936.
(*v*) Round one tree in December 1936.

Of the May batch, two trees failed to sucker and the remaining suckered in July 1936. Of the July batch, one tree failed, four suckered in September and one in November. The trees trenched in September, November and December all suckered but the time of suckering has not been recorded. Fences were erected round all trees which suckered.

In January 1937, the suckers were thinned, a few strong ones being retained round each tree. The suckers have persisted: the height in March 1938 ranged from 2′ to 11′, the average being about 5′.

Experiment III.

(Compartment 17, Kothari Felling Series.)

Trenches were dug round 20 standing trees in August 1938 at 25′. In the case of ten, the lateral roots were cut right through and in the case of the remaining ten, the roots were merely bruised. All the trees either completely failed or gave a few weak suckers which did not persist.

Experiment IV.

(Compartment 16, Kothari Felling Series.)

In April and May 1937, stumps of trees felled during the cold season of 1936 were treated in the following manner, 25 stumps being treated in each group:

(*i*) Cutting large lateral roots close to the parent stumps.

(*ii*) As in (*i*), but exposing the lateral roots.

(*iii*) As in (*ii*), but wounding the lateral roots at intervals.

(*iv*) As in (*ii*), but cutting the lateral roots half through at intervals.

(*v*) As in (*ii*), but cutting the lateral roots right through at intervals.

Practically all the stumps suckered. In July 1937, about 75 per cent. were fenced at random and the remaining left unfenced.

Chital browsed and killed all the unfenced suckers, but the fenced ones have persisted. A thinning was carried out in October 1937, leaving 1-5 strong suckers per stump. The height in March 1938 ranged from 2′ to $6\frac{1}{2}$′, all the groups being more or less alike in this respect.

It is difficult to draw any definite inferences but the following points are significant:

(*i*) *Semal* can be regenerated from root suckers by cutting or bruising the large lateral roots of standing trees or fresh stumps.

(*ii*) Cutting or bruising of thin roots far away from the parent trees or stumps does not give good results.

(*iii*) Fencing against *chital* appears to be essential

It is difficult to say at this stage what time of the year is most suitable for bruising or cutting the lateral roots.

NOTES ON SOME WOOD-WORKING INDUSTRIES IN THE PUNJAB

By S. N. Kapur, Officer-in-Charge, Wood Seasoning Section.

Summary.—With a change in Indian requirements due to the effect of Western civilisation, a number of new woodworking industries have sprung up in the Punjab, such as the manufacture of wooden heels for ladies' shoes, gramophone and radio cabinets, bobbins, shuttles and other requirements for hand and power looms, picture frame mouldings, electrical casings, etc. Some of these newly developed industries are briefly described in the paper, discussing their economic aspects, and indicating the woods that have been found suitable for particular purposes. It is suggested that a country-wide survey of the existing woodworking industries should be carried out, to collect information on their technical and economic features, in order to be able to further their growth, and to introduce new industries in the country.

That necessity is the mother of invention is an oft repeated adage, the truth of which is very well illustrated by the development of Indian industries. The contact of the East and West, the rapid increase in the Western system of education, and the effect of Western civilisation in general on the Indian mode of thought and living, has made a tremendous change in the country's requirements, which in turn is reflected in the growth of India's industrial life. The old handicrafts are fast disappearing and new ones are taking their place. The bullock-cart has given place to the motor lorry, the preparation of *gur* from cane juice has been elaborated into the manufacture of refined sugar, the simple tanning of sheep and goat skins with *Acacia* bark has been replaced by the chrome process, and so on in innumerable other lines. In the wood-working sphere such new ideas have been taken up as the manufacture of heels for ladies' shoes; gramophone and radio cabinets; bobbins, shuttles and other requirements for hand and power looms; picture-frame mouldings; electrical casings and many similar articles which were unknown to the small wood-worker a couple of decades back, while the native handicrafts for which the country was famous, such as wood carvings and lacquered and inlaid work, are being practised by very few people, and those few find the work unremunerative.

Having recently visited some of the wood-working centres in the Punjab, the writer was forcibly struck by the fact that the growth of these industries has been entirely on a cottage industry scale, and although electric power is used to a limited extent for driving the simple home-made machinery, most of the operations are carried out

by manual labour alone. Further, it was observed that the quality of the hand-made articles is in no way inferior to machine-made products and the prices are certainly lower, so that the workers find a ready market for their wares in competition with the machine-made articles which are chiefly imported from abroad.

The growth of any industry in a country is greatly influenced by the local conditions of market and labour. The Indian market certainly favours lower grade production on account of the poverty and illiteracy of the consuming public, and Indian labour is cheap, abundant and efficient, although it has often been styled as incompetent by people who do not themselves really understand the manner in which to make the best use of it. These being the conditions of the Indian market and labour, there is not much scope for the up-to-date machinery developed for use in Europe and America, particularly for small wood-working industries. The huge saw-mills of the United States of America, especially those on the West Coast, where every operation from the conveying of the logs from the pond to the saw-mill, to the packing of the beautifully edged and planed planks of kiln-dried wood into bundles for export, is done by mechanical power, cannot be transplanted to Indian soil. Even in a highly industrialised European country like Germany such an exotic plant would hardly thrive. Some of these saw-mills are equipped with over 150 timber drying kilns, each kiln being about 110 feet long, and one week's production of kiln-dried material from one such mill would probably cover the entire annual requirements of sawn material of one of India's major provinces.

Speaking of seasoning kilns, one must admit that efforts to introduce up-to-date methods of drying wood in this country have not met with any great success on account of the lack of any large-scale saw-milling and wood-working industry. Efforts have been continuously made to simplify the design as well as the operation of a seasoning kiln, so that it is now possible to build a small steam-heated drying chamber with a charging capacity of about 250 c.ft. of sawn timber at a cost of about Rs. 3,000, including a steam boiler and the necessary laboratory equipment. But it appears that even this amount is too much for the average wood-working establishment in this country, although people are beginning to realize the benefits of proper seasoning of wood before use, and earnestly desire to have some simple

means of rapidly seasoning wood. The Forest Research Institute is now attempting to evolve a simple type of furnace kiln, which will work without a steam boiler and without any kind of motive power, will be simple to erect and operate, and the total cost of which will be under a thousand rupees. Such a kiln may not be very efficient and may not be suitable for all purposes, but it would undoubtedly meet the requirements of a large number of wood-working concerns in this country. A drying chamber of this type would be called antiquated in Europe, and its design would probably be ridiculed in a progressive country like the United States, but Indian conditions are entirely different to other countries and as things are at present it is well-nigh impossible to popularise anything more modern than this in India.

The same factor of cheapness applies with equal force to other small wood-working industries. From the information collected, it is found that Indian wood-workers are able to produce by hand and sell such articles as wooden heels, picture-frame moulding, shoe lasts, electrical casings, bobbins, reels and weft pirns, and numerous other articles at a much lower price than that of similar machine-made imported articles, and the quality and finish of the hand-made products is in no way inferior to those made by machinery. As an illustration, it may be recorded that one man working on a Kirchner copying lathe, costing about Rs. 4,000, takes from 20 to 40 minutes to turn out a pair of shoe lasts, to which must be added the time and labour required for first making the half-wrought, and also the time spent on the final polishing and finishing. Against this, an average hand worker, with the help of a young boy who is paid only two annas a day, can turn out six pairs of well finished shoe lasts in a day, and his capital investment is practically nil.

In order to further the growth of any wood-working industry in this country, it is imperative to study the manner of its development, both technical and economic, and also its scope and future possibilities, and then to find out the best ways and means to help those actually engaged in it. In a large number of cases it would simply mean some improvement in the handling, treatment and seasoning of the wood, or arranging for regular supplies of suitable woods, or some slight changes in the manufacturing technique which would not

entail any heavy capital cost, and finally the creation of a marketing organization, the absence of which severely handicaps the manual worker, and keeps him always at the mercy of the middleman to whom most of the profits go.

With regard to improvement in the manufacturing technique there is considerable scope for this in many small wood-working industries, and the workers are not unwilling to act on sound advice offered to them, provided their confidence is gained to begin with. They are as a class generally rather suspicious of the motives of government officers, and the advice suggested must be practical and not entail large capital expenditure. In addition to the improvement of existing industries many new industries could be started in areas where they have not yet been taken up. For this purpose it is necessary that a survey should be undertaken throughout the country, with the help of local officials of the Forest, Agriculture, Industries, Co-operative and other government departments, to collect information on the technical and economic aspects of the industries that already exist. The information available on the uses of various Indian woods, collected by Gamble, Troup, Pearson and others needs supplementing in some respects, and it is necessary to know what woods have been found suitable by Indian workers for the modern requirements of wood-work, how they obtain supplies of those woods, and what steps should be taken to ensure a more regular supply of suitable woods. In many cases, these woods are obtained from other sources than Government forests, such as from private estates, from trees growing on road-sides and canal banks, and from Indian States. The Forest Department itself may not therefore be directly and wholly interested in the supply of such woods, but in the broader interests of the welfare of the country as a whole, a survey on the lines mentioned above is very desirable. It will be found that sometimes very valuable information is obtained by making personal contact with the people most concerned, namely those who have accumulated a lifetime's experience in some one or other industry relating to wood-working.

In the following notes, the present position of some of the more important small wood-working industries in the Punjab is indicated. The information given is by no means final or exhaustive, as it was collected in the course of a very short stay in Amritsar, Lahore and

Jullundur, the chief centres of wood-working industries, but it does give some idea of what is actually going on in these parts.

(1) *Picture-frame moulding.*—The chief centres are Lahore and Amritsar, where a large number of workers are engaged in this industry. The wood used is fir (*partal*) which is obtained either in the form of railway sleepers from Dhilwan, or in the form of logs from Jhelum. The material is converted on a band-saw into strips of the proper size. Some of the bigger producers have their own band-saws, while the majority of workers have their material sawn on payment, the usual sawing charges being 16 square yards* of saw cut for a rupee. The sawn strips are allowed to air-dry in irregular heaps for three to four days, and there does not appear to be any great damage due to warping and twisting of the wood. The moulding, planing and rebating are all done usually by hand, as manual labour is extremely cheap. From one B. G. sleeper, $9' \times 10'' \times 5''$, 18 bundles of half-inch moulding are obtained, each bundle containing eight sticks of 9 feet length. It is rather astonishing to know, but is nevertheless a fact, that the labour charges for making picture-frame moulding from one sleeper are annas four only, which includes all the operations of moulding, planing and rebating for practically 1,300 linear feet of $\frac{1}{2}''$ wide strips. One man can ordinarily work two sleepers a day, which brings him an earning of annas eight only. People have tried to introduce simple home-made machinery to do this work, but the cost of operation is just about the same as the labour charges for manual work, with no additional advantage. At one place it was seen that strips were converted to double widths, that is a little over one inch wide for half inch wide framing stock, and the moulding on top of the face was done by hand in one operation. The strips were then passed on to a bench, having two cutters and one circular saw, so that the conversion into two strips and the rebating of each width was done simultaneously. Even this machine does not appear to hold any advantage over hand-work.

The moulding has then to be finished, which includes sand-papering and giving four to five coats of a spirit varnish or some kind of varnish-paint. One or two lines in gold (bronze powder) are usually necessary, and the sticks are wrapped in brown packing paper in the

*One square yard is considered equivalent to $32'' \times 32''$ for the purpose of reckoning sawing charges.

form of bundles which are sold at a uniform price of about annas eight to ten per bundle, depending on the quality and finish but irrespective of width as the number of sticks in a bundle vary. The length of a stick is either 8 or 9 feet, and the following lengths are contained in a bundle:

Width of moulding.	*No. of sticks.*	*Total length of 9 feet sticks.*
$\frac{1}{2}''$	8	72 feet
$\frac{3}{4}''$	6	54 "
$1''$	4	36 "
$1\frac{1}{2}''$	3	27 "

The cost of manufacture is roughly as follows:

		Rs.	a.	p.
Cost of one B. G. sleeper of fir or spruce	...	2	4	0
Cost of sawing into strips	...	0	12	0
Labour charges for moulding	...	0	4	0
Polishing, finishing, etc.	...	2	8	0
Total	...	5	12	0

From a first-class selected sleeper, 18 bundles of any width can be obtained, but in practice the yield is not more than 14 to 15 bundles, on account of the presence of knots, shakes, cracks, etc., in the wood. The cost of a bundle of picture-frame moulding thus comes to about six to seven annas, which leaves a margin of about two to three annas per bundle, part of which goes to the maker and part to the wholesale dealer.

It is essential that the wood used for the purpose should be light and soft, so that it can be nailed without splitting. Among the Indian conifers, deodar is the easiest to work, but it is too costly to be used for picture-frame moulding. *Kail* is considered better than fir and spruce, but the latter are preferred on account of their low cost. The wood from Jhelum which is extracted from the Kashmir forests is said to be softer to work than that which comes from Beas. Softness of wood is an essential quality, and sometimes deal wood packing cases in which motor cars and heavy machinery are imported from abroad are used for making picture-frame mouldings, and the finished article fetches a better price in the market on account of the softness of the

wood. Among the hardwoods, *semul* (*Bombax malabaricum*) has been tried by some of the workers, and found to be sufficiently soft and suitable, but its high price in the Punjab market, about a rupee per cubic foot, excludes it from this work. The wood is also subject to slight twisting and mould discolouration. These can, however, be avoided by converting the logs into plank of the required thickness, air-drying in vertical stacks for a week to 10 days and reconversion into strips. In other parts of the country where conifers are not available, *semul* would perhaps be the most suitable wood.

At present all the requirements of the Punjab and also of the neighbouring areas for the cheaper varieties of picture-frame moulding are met with by local production. It is only the superior qualities, which have a plaster composition covering, that are imported from abroad, chiefly from Belgium, Norway and Germany. The demand for the cheaper varieties is very large, particularly about *divali* time (October), when very large quantities are sold for framing pictures and looking-glasses of inferior quality. Many people have tried to make moulding with plaster composition, but nobody has so far been successful in making an article equal in quality to the imported one. The principal defects are firstly the chipping off of the composition due to either brittleness of the composition or a lack of proper adherence to the wood, and, secondly, to slight shrinkage and swelling with change in weather conditions. One firm in Amritsar did attempt to make and sell composition moulding, which fetched in the market a price of about Re. 1-8-0 per bundle, as against eight annas per bundle of ordinary moulding, but on account of the above mentioned defects which came to light later, the manufacture has come to an end. The price of the imported article is, roughly, about annas eight per stick of 8′ length for $\frac{1}{2}''$ width, up to about Rs. 2 per stick for 2″ width, so that if a suitable composition can be found, the manufacture of this line would be an attractive business proposition.

(2) *Electrical casings.*—With the widespread use of electricity in the province for home and industrial purposes, the manufacture of electrical casings has become an important industry. The wood used for the purpose in the Punjab is entirely Burma teak, which is imported in the form of strips $1\frac{1}{2}'' \times \frac{1}{2}''$. The strips are sold in the market at Rs. 3-10-0 per c.ft. in lengths varying from 3 to 5 feet and

at Rs. 4-10-0 per c.ft. in lengths of 6 feet and over. One cubic foot of wood yields 200 running feet of casing. The wood is sawn on a band-saw into capping and casing, the former being $\frac{1}{8}''$ and the latter $\frac{3}{8}''$ thick. The capping is planed by hand, and grooves in the casing are made by a simple home-made machinery driven by electric motor. For shorter lengths, the cost of wood for 100 feet is Re. 1-13-0, the cost of sawing two annas and the labour for manufacturing and finishing six annas, the total cost coming to about Rs. 2-5-0. The dealers buy the casing at about Rs. 2-8-0 per 100 feet and the selling price is about Rs. 2-12-0. The lengths 6 feet and over are sold at Rs. 3-4-0 per 100 feet. The margin of profit to the maker is about annas three to four per 100 feet. Sometimes teakwood from rejected railway carriages is used for the purpose. No other wood except teak can be used, as, according to the government regulations, only teak is permissible for this work. It is interesting to note that teak is imported in various small dimensions, which are used for different purposes. For instance battens, $1'' \times 1''$, in lengths varying from $1\frac{1}{2}$ to $2\frac{1}{2}$ feet are available in the market at Rs. 2-4-0 per c.ft. These are made into plugs, $1\frac{1}{2}''$ long, tapered at one end, and are sold at annas five per 100. Teak is imported in many other sizes in the market, each one finding a particular use.

(3) *Wooden heels.*—This industry is of recent origin and there are about a hundred persons engaged in it at Amritsar alone. Most of the people make the cheaper varieties which sell at annas six to annas ten per score pairs, there being 20 to 30 expert workmen who make the superior quality which compete very favourably with the imported article. The prices of the better finished heels vary according to sizes from annas eight for $\frac{1}{2}''$ and $\frac{3}{4}''$ thick to Re. 1 for $2''$ thick heels for a dozen pairs. These prices are about 33 per cent. cheaper than the market prices of the imported heels.

The only wood used for the purpose is mango, and I was told that with regard to its property of taking nails without splitting it is superior to beech of which the imported heels are made. The wood is obtained from big logs as the branch wood is too soft for the purpose, yielding heels of very low quality. It is purchased ready sawn in the form of battens about 2 feet in length and of the required width and thickness, and is available in the market at about annas eight per maund in green condition, containing as I estimated about

100 per cent moisture or more. It is essential that the wood should be absolutely wet, as dry wood is much too difficult to work.

The manufacturing operations are all carried out by hand. The shape of the heels is marked with a pencil on the batten, which is sawn into rough blocks. These are first chiselled into rough shape, and then finished into the proper form by chisels and gouges of various types, which are all home-made. The finishing is first done on the back side, which is more or less semi-circular, then on the front side, then on the top, and finally the bottom which is surfaced by means of a planer while the heel is held fast in a slot in a wooden board. At the end of all these operations, the heels are still wet to touch and before finishing are allowed to air-dry in the shop for a few days in open baskets. When they are sufficiently dry they are sand-papered, which operation is carried out by young boys. In order to get a good finish, the heels are arranged round a shallow earthenware pan containing burning charcoal, and as soon as one is removed for sand-papering another is placed in the situation. Every heel therefore gets an exposure of about half an hour to charcoal fire which is sufficient to give the surface a good finish. At one place I examined a large number of heels in various stages of manufacture and did not notice any cracking at all. The heels are stamped in continental sizes, with the size of shoe for which they are meant, and are sold according to thickness. In appearance and finish they do not look in any way inferior to the imported heels.

A good workman turns out on an average two to three dozen pairs of heels in a day and his daily earnings amount to annas twelve to a rupee. The boys who do the finishing are paid only about two annas a day. The industry is rapidly expanding. No other local wood has so far been found suitable for this purpose.

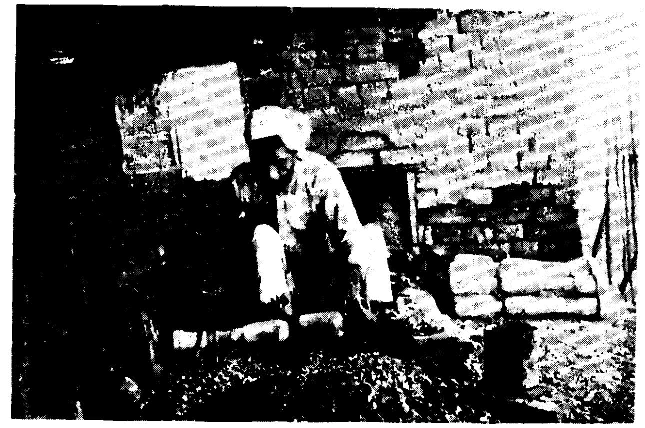
(4) *Bobbins, reels, weft pirns, etc.*—The manufacture of these has also become a well established cottage industry, and all the requirements of local hand-looms are met with by local production. The wood chiefly used for the purpose is a variety of pear, which is at present available at Amritsar in sufficient quantities on account of the extension of the town which has necessitated the clearance of a number of old gardens of pear trees round about the city. But it is gradually getting scarce. Other woods that can be used for the purpose are *luquat* (*Eriobotrya japonica*), *guava* (*Psidium guava*), and

mulberry (*Morus* spp.), but none of these is so good as pear, and in order to ensure regular supplies of this wood to an expanding industry it is necessary that plantations of this wood should be established either by the Forest or the Agriculture Department in the vicinity of Amritsar, Ludhiana and other towns where hand-loom weaving is carried out on a large scale. Sapwood of sissoo is also a good turnery wood and is used all over the province for the manufacture of toys, specially of the lacquered variety, but it lacks the smooth finish and wearing quality of pearwood, and is not therefore in demand for this work as long as pearwood is easily and cheaply available.

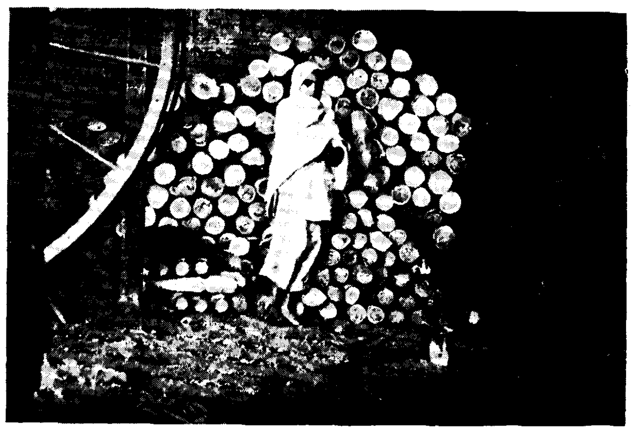
The lathe is of the simplest kind, a home-made contrivance consisting of a fast and loose pulley, and a spindle running in ball-bearings. The tools are made of old files. The man squats on the ground, the tool is held by one or both hands, and is guided by his feet which rest on a wooden block. With this simple kind of lathe, a worker can produce in hundreds an exact replica of any type of bobbin or reel given to him. The other end of the spindle is provided with a hollow conical attachment in which a bobbin or reel can be held fast by friction, and is used for drilling the central hole, which is done in two operations, about $\frac{3}{4}''$ the length from one end and the remainder after changing over the end. The drilling operation is carried out by a boy who sits across the length of the lathe. Usually two or three such lathes are fitted in a small room, say about $12' \times 15'$. The motive power is electricity.

The wood is first converted into battens of proper thickness on a band-saw, which are again cross-cut by a hand-saw into suitable lengths. These are first given rough shape on the lathe while quite green, and the half-wroughts are allowed to dry in the sun for three to four days, as it is necessary that the wood should be sufficiently dry for a proper finish to be given to the bobbins. The half-wroughts are then finished to proper shape and size, sand-papered, drilled, and in some cases given a coat of spirit varnish. Boys do a lot of work, such as cross-cutting, drilling and varnishing and are paid very low wages. A man can turn out about 600 pirns a day or about 400 to 500 reels depending upon the size. The weft pirns are sold at annas ten to twelve per hundred, while the reels fetch from Rs. 2-8-0 to Rs. 4 per 100. Allowing for all incidental expenditure a man earns on an average from Re. 1-8-0 to Rs. 2 per day.

A worker making wooden beds. His only tools are a few home-made chisels, with which he can turn out as good beds as the imported machine-made articles.



Bed-legs being turned on a hand lathe. His eyes are the sole judgment to enable him to maintain uniformity in shape and size.



A store of mulberry branch wood to be turned into bed-legs. The boy in front earns while he learns, though he is paid little compared with the amount of work he does.

Making lacquered bed-legs. This type of bed-legs is fast getting out of fashion.

(5) *Bed legs.*—This is an old cottage industry in the Punjab, existing since time immemorial in practically every large town and village, but with the introduction of motive power for driving the manufacturing processes have been greatly speeded. Originally bed legs were made from branch wood of either sissoo, mulberry or *bakain* (*Melia azedarach*), the last one being said to be immune to insect attack, but at present sissoo logs are used almost entirely for the purpose. The wood is obtained in the form of logs mostly from the Changa Manga plantations, and cost at Amritsar about Re. 1 per c.ft. The wood is converted on a band-saw into scantlings of the required thickness, which are allowed to air-dry for a couple of weeks either as such or in the form of half-wroughts. The manufacture is done on power-driven lathes, which are of simple home-made construction, the worker squatting on the ground as in the manufacture of bobbins. It takes about 10 to 15 minutes to finish a bed leg, and it is remarkable to note that a worker can produce any number of legs exactly similar in all details, without any measuring and controlling contrivance. The off-cuts from logs are sold at annas nine a maund, and even saw-dust fetches annas seven a bag and turnery shaving annas seven a maund. The scarcity of wood in the Punjab necessitates an economical use of all waste products.

A firm in Ludhiana started the manufacture of bed legs with up-to-date imported machinery about 10 years ago, but on account of competition with the hand-made article came to a close in a short time.

(6) *Hood frames for tongas.*—One set consists of five pieces, one of which is about $2\frac{1}{2}''$ wide and the remainder $1\frac{1}{2}''$ wide, $\frac{7}{8}''$ thick and about 8 to 10 feet in length, bent in the form of "U." These were previously imported from abroad, very likely made of ash, but the home production now meets the entire demand, which is by no means small. The manufacture is being carried out in several towns, Sialkot, Lahore, Amritsar, Pathankot and in many other places.

The wood used for the purpose is entirely mango, though *Ulmus wallichiana*, I was told, had been found suitable. The material is sawn in the form of strips, $3'' \times \frac{7}{8}'' \times 8$ to 10 feet which are boiled in water for a couple of hours, and then bent on a simple kind of press without any tension strip. The bent material is allowed to dry in a wooden clamp for two to three days, after which the ends are

bound with a tight rope to prevent the opening out of the bend. The strips are resawn on the hand-saw to half the width, and sets of five pieces assembled together, the ends of which are bound with rope. The sets are sold in this condition, and the present price is Rs. 10 to Rs. 15 per dozen sets, although when the industry was started the price was as high as Rs. 65 per dozen sets.

The wood is obtained chiefly from Pathankot in the form of logs costing about annas ten per c.ft. at Amritsar. The breakages in the manufacture vary with the quality of the wood. In the case of some logs the wood is very elastic and no breakage occurs at all, while in others the losses due to breakage are very heavy.

(7) *Footrules and drawing instruments.*—The centre of industry is in Lahore, and except for one firm which specializes in high quality drawing instruments and articles of school stationery, most of the people are engaged in turning out the cheaper variety of footrules.

The only wood used for the manufacture of footrules is *partal* (fir and spruce), which is obtained from Jhelum in the form of round logs. The logs are squared by axe and slabbed into two or four pieces by band-sawyers. The slabs are converted on a band-saw into strips of the required thickness and width, and cross cut into proper lengths. These footrule blanks are left in large heaps in some convenient place where they are exposed to air and the sun, and allowed to dry for one to three days before the finishing process. In order to get uniform drying and avoid damage due to warping, etc., the material is frequently turned so as to expose all the pieces to air. I was told that no appreciable damage is done on account of seasoning losses, although the work gets held up in the rainy weather. The finishing of the footrules is done by hand-planing, which is cheaper than machine work. The printing is done on an ordinary printing machine, and each footrule has to be given three impressions, one on the flat side and two on the side with bevelled edges. A fourth impression is necessary if an advertisement is to be printed. The footrules are then usually stained yellow and given a coat of spirit varnish. The prices of the most common variety in the market are Re. 1 per gross for 6″ rules, and Re. 1-8-0 per gross for 1′ rules, although superior varieties fetch about 50 per cent extra.

In connection with our efforts for obtaining supplies of boxwood for the manufacture of shuttles for hand-looms, there are bound to be

considerable rejections of material in the form of blocks 13" × 1½" × 1¼" as the wood for the shuttle manufacture must necessarily be free from cracks, knots, shakes, etc. The rejected material, I am sure, can find a good market for the manufacture of superior quality footrules, and I had a talk with one of the firms who were agreeable to purchase it at a decent price and make a trial. The manufacture of folding two-foot rules, which are imported in very large quantities, is another likely industry which can be taken up if cheap boxwood is available.

The drawing instruments are chiefly made of walnut (*Juglans regia*) and *gun* (*Aesculus* spp.), which are obtained from Kashmir. These woods are costly to extract and I suggested to some of the firms that they should use well dried *toon* from Saharanpur for this work.

(8) *Folding chairs.*—Folding chairs, which are an almost exact copy of the imported "Venesta" chairs, are made at Jullundur by a very progressive firm of wood and metal workers. The woods used for the manufacture are mulberry and sissoo, and out of these two the former is preferred on account of its light weight and colour. Only smaller logs of mulberry are obtained which are not fit for the manufacture of sports goods, as high prices cannot be paid for this work. The plywood seats are imported from abroad, chiefly from the Baltic States, and cost from Rs. 2-8-0 to Rs. 3-4-0 per dozen seats. The chairs are sold for Rs. 19 to Rs. 24 per dozen, and find a ready market.

(9) *Shoe lasts.*—The manufacture of shoe lasts is carried out in almost all the big towns in the province and the wood used for the purpose is chiefly sissoo. The imported shoe lasts of beech do not last half as long as those made of sissoo, and their import is entirely due to their better shape, but since the native workers have improved the quality of their manufacture and now produce as good shapes as those of the imported ones, the foreign supplies are dwindling in the market. As a comparison, it may be stated that the Indian made lasts of superior quality are sold in the wholesale market at Rs. 9 per dozen pairs, while the imported ones cost Rs. 15 per dozen pairs. With regard to the property of sissoo to withstand repeated nailing, I have seen saddle lasts of this wood which have been in use for years and are still giving good service. In this regard I must say that this wood is really wonderful.

Besides sissoo the only other woods that have been found useful for the purpose, I was told, are *moru* oak (*Quercus dilatata*) and

chamror (*Ehretia laevis*), but the information requires verification, as I have not seen any last made of these woods. The latter is also said to be good for heels. Sissoo is purchased in the form of branch wood, 9″ to 12″ in diameter, at a cost of annas eight a maund. The rough blocks are first made by means of an adze and the finishing is done by home made chisels and gouges. The finished lasts are then sand-papered and given one or more coats of a spirit varnish, probably containing gum sandarac. A man and a boy can together turn out six pairs a day working for 8 to 12 hours, which compares very favourably with the machine output. The cost of wood for a pair of lasts comes to about two annas six pies. The shavings and off-cuts find a ready market at annas six a maund. A slight amount of sapwood in the upper part of the last is not objected to.

(10) *Combs.*—Amritsar has been the centre of this industry for a long time and although in Eve's toilet, the more attractive and better finished imported combs of celluloid and vulcanite have replaced those made of wood, yet there is a steady demand for wooden combs among the Sikhs who have to wear one in their hair as a religious emblem. The industry is entirely carried out by hand and although factories with imported machinery were set up by two enterprising firms, they failed to compete with the hand-worker and are not working at present.

The combs are made of various woods, among which *chikri* or *shamshad* (*Buxus* spp.) is the most important. It is obtained from Tehri, Mandi, Chamba and other hill States and is sold in the market at about Rs. 5 to Rs. 8 per maund. About a thousand maunds of this wood are sold annually for this work.

Other woods which are used for the purpose are:

(*i*) *Adina cordifolia* (*haldu*).—Price varies from Re. 1 to Rs. 2 per maund according to quality. This wood also finds a good market.

(*ii*) *Gardenia* spp. (*papri*).—It is obtained from somewhere near Allahabad and is sold at about Re. 1 per maund. It is said to be a good substitute for boxwood, although it does not take as good polish.

(*iii*) *Crataeva religiosa* (*barna*).—It is obtained from Hoshiarpur and is a bit soft.

(*iv*) *Olea ferruginea* (*kahu*).—Comes from North-West Frontier Province and is very hard to work.

(*v*) *Acer* spp.—The combs come ready from Kashmir and are sold at a high price, but their market is decreasing.

(11) *Musical instruments.*—The manufacture of stringed instruments of various types is a very old industry at Amritsar and no other wood except toon is used for the purpose. The wood is said to possess some qualities of resonance for which it is preferred. The wood is allowed to season for a year or two and is then said to give no trouble due to warping or twisting.

Even for harmonium cabinets, I was told by one of the oldest makers that he would prefer toon to any other wood on account of its lightness, colour, grain, steadiness, resonance and ability to take glue well. Teak is used at present for this work, as well dried *toon* is not easily available in the Punjab market, but the reed boxes are made of kail (*Pinus excelsa*), teak having very poor resonance properties.

The manufacture of gramophone and radio cabinets is also a growing industry, and exact replicas of the H. M. V. gramophone models in Burma teak are sold at a very cheap price. Teak is the only wood in demand for this work.

It may be interesting to mention that Indian drums (*dholkis*) are entirely made of mango, the drum being hollowed out from a round log. No other wood is said to serve the purpose equally well.

(12) *Tongas and carts.*—Sissoo and babul are the two woods which are chiefly used for the purpose. The tonga body is usually built of sissoo, except the seat for which any light wood may be used to reduce the weight of the tonga. The tonga wheels are also made of sissoo, except the spokes which are always of babul. In the case of carts, the felloes are also of babul.

The tonga shafts may be of bamboo or mulberry. Indian ash (*Fraxinus excelsior*) is also said to be suitable, but it is not easily available. The bamboo shafts are used straight, but the mulberry is bent to shape. The bending is done while the wood is in a green condition, or after prolonged soaking in water if the wood is dry. The wood is locally heated on an open fire and is bent by hand between pegs. To prevent cracking of the wood during the process of bending, vegetable oil is applied to the portion being bent, and is said to be of great help. The shaft is left to dry for 6 to 8 hours held in position, during which time the bend gets set. The rounding and finishing of the shaft is done after bending as it is then

possible to get rid of any cracks that may have appeared during the process.

(13) *Tool handles.*—As far as I have been able to ascertain no wood for tool handles is imported into the Punjab from abroad, as *kahu* (*Olea ferruginea*) is available in plenty in the market, and is pre-eminently the most suitable wood for the purpose. The wholesale price in the market varies according to length and thickness. Billets 3 feet in length and about 1″ to $1\frac{1}{4}$″ in thickness are sold at Rs. 10-8-0 per 100, while those 4 feet in length and up to $1\frac{1}{2}$″ in thickness are sold at Rs. 17 per 100. For ordinary axes and *kudalis*, these billets are used as such without any preparation, but for supply to the Public Works Departments and other Government Departments for sledge hammers, etc., the handles are turned to shape on a hand-lathe.

Incidentally it may be mentioned that there is a big market for this wood in the Punjab. It is used for combs as previously mentioned, for simple kinds of shuttles for hand weaving of silk, for handles of hand *punkhas* (fans), for pestles, for beams of scales and for many other purposes. The chief source of supply is the North-West Frontier Province, and Peshawar is its centre of trade. Well turned balance beams of *kahu*, 30″ long and 1″ in diameter are sold at seven for a rupee, while sissoo beams of the same dimensions are sold at 12 for a rupee, and bamboo beams at 14 for a rupee. *Kahu* beams on account of their strength are, however, much preferred to sissoo and bamboo beams.

(14) *Sports goods.*—Sialkot is the centre of this industry, and besides a few big factories there are a large number of cottage workers engaged in the manufacture of sports goods. The extent of the industry can be gauged from the fact that some of the big firms have their permanent offices or representatives in London, Berlin and other European towns, and considerable export trade is carried out in sports goods from Sialkot. Recently the industry has suffered on account of the Japanese competition.

The most important Indian wood for hockey sticks, tennis and badminton rackets is mulberry which is obtained from the Changa Manga plantation. Willow from Kashmir is used for cricket bats. Many other woods are used in smaller quantities. A detailed description of the growth and development of this industry will be given in a later paper.

(15) *Carving and inlaid work.*—These are some of the old handicrafts which are fast disappearing. The modern public has little use for any but utility articles. Carved doors, windows and mantle-pieces are looked upon as old fashioned and are seldom used in modern constructions. The Government have tried to popularize Indian handicrafts abroad by exhibiting some of the choicest articles in world exhibitions, but no permanent trade has resulted. With changed conditions of living I doubt whether anything can be done to revive the industry to its past glory, but much can be done to divert the knowledge and experience of these people to the manufacturing of toys, cigarette and cigar cases, and other utility articles now being imported from Japan.

The chief wood for carving and inlaid work is sissoo and one of the centres of industry is the Hoshiarpur-Jullundur area. I must say that some of the work done is extremely fine, but the workers get little encouragement and small wages.

Carving of dies for calico printing is another important industry in the Punjab. The carving is done on the cross face, care being taken that the heart centre is not included in the die. Before use, the dies are soaked in vegetable oil to prevent the absorption of moisture during use. This treatment is said to increase the life of dies considerably.

(16) *Wooden shoes ("chappals").*—These are made of sissoo, which is cut in the form of $\frac{1}{2}''$ thick planks, mostly from the branch wood. The planks are sawn into proper shape on a home-made treadle saw bench, which is shown in one of the photographs. The hefty boys who work on these saws give certainly an impression of speed and energy, and the cutting, I must say, is really done at a very rapid rate. The wooden soles are allowed to dry in the sun, and finally a cotton strap is nailed to each to complete the *chappal.*

(17) *Type case.*—The demand is small but the prices obtainable are good. Kail is used for frames and fir and spruce for the bottom and partitions.

(18) *Press leads.*—Deodar is used for the purpose. The usual size is $2' \times \frac{3}{4}'' \times$ varying thicknesses from less than $1/16''$ to a little over $1/8''$. The demand is good, and the market price is about Re. 1 per 100 feet.

(19) *Sieve frames.*—Cheap variety of household sieves are made of wire guaze attached to a wooden frame. The usual size is a foot in diameter, for which a thin strip of wood about 3/16" thick and 3" wide is bent round in the form of a cylinder. The wood used for the purpose is *frash* (*Tamarix articulata*) which is available in most parts of the Punjab and the United Provinces. The bending is done immediately after sawing, while the wood is green. The cost of a sieve frame is about half an anna. I consider that rotary cut veneers will prove cheap and better for the purpose.

(20) *Patterns for foundry work.*—Having consulted a number of iron and brass founders, I have been told that deodar is the best wood for the purpose, as it does not swell appreciably after coming in contact with wet sand, takes a fine finish and gives very sharp castings.

(21) *Cane presses.*—One of the photographs illustrates a primitive type of cane press which is still in use in many towns and villages for pressing cane juice which is used either as a beverage or for cooking purposes. The press rollers are usually made of babul (*Acacia arabica*), although *phulai* (*Acacia modesta*) is said to be better, but is very hard to work.

(22) *Toys and lacquered ware.*—This is also one of the old handicrafts of the province, and is carried out in many small and large towns, although the demand for these toys has considerably decreased and is further decreasing.

The wood used for the purpose is chiefly sissoo sapwood although babul sapwood is also used. The latter is said to take better polish and is stronger than sissoo sapwood. Besides toys, many other articles are made, such as wooden cups, bowls, vases, mortars, and recently some demand has arisen for electric lamp stands. The wood is first turned on the hand lathe into rough shape while quite green, allowed to dry in the sun, and then finished and lacquered on the lathe. The lacquering cannot be done unless the wood is thoroughly dry, and in the process of sun-drying I did not notice any serious cracking of the wooden half-wroughts.

In the foregoing notes I have indicated briefly some of the wood-working industries that are being carried out in a few of the districts of the Punjab, the woods that have been found suitable for particular uses, and have also discussed in some cases the economic aspects of

A treadle fret saw for cutting out wooden shoes from sissoo planks. The picture does not convey the idea of rapidity with which the fellow works.

An old-fashioned but nevertheless a very efficient cane-juice press. The making and setting of rollers require great skill.

A door-frame of sissoo used in village houses. These frames are very strong and durable, but not finished to suit modern requirements.

the industries concerned. A survey of this kind has many uses. Apart from the valuable information collected on the property and uses of our indigenous woods, one comes in direct touch with the people who with their knowledge, hard work and enterprise have succeeded in establishing one or the other industry connected with wood-working, and who are willing to carry out further trials if necessary help is offered to them. It is my conviction that the growth of our wood-working industries rests more with this type of individual than with the type of people who put forward ambitious and costly schemes which never come to fruition.

Apart from information on the technical side of wood utilisation, the knowledge of which will be greatly augmented by such an all-India survey, the information obtained on the economic aspects of an industry is very useful indeed. People sometimes put up fabulous figures regarding the value of imports of a certain article and about the estimated yield of profits. For instance, I have recently come across a statement that the imports of picture-frame moulding in Madras amount to about 10 lakhs of rupees, whereas, according to my estimate, the imports of this item for the whole of India do not exceed about half that sum. An accurate knowledge of the possibilities and profitableness of the wood-working industry, if available at the Institute, will surely be of great use to prospective manufacturers.

GRASS FLORA OF THE KOLLEGAL FOREST DIVISION WITH SHORT NOTES AND VERNACULAR NAMES WHEREVER AVAILABLE

BY K. CHERIAN JACOB, L.AG., F.L.S.

Abstract.—Describes a survey of the grass flora of the Kollegal Forest Division in the Coimbatore District. The grasses in this Forest Division are very important since one half of the forest revenue of this Division is derived out of the grazing permits issued to cattle owners.

Sixty-five out of 390 species of the Madras grasses from an area of about 1,000 square miles were collected. 40 of these are good fodder grasses. Short notes on the fodder value are given for all the species of grasses. A few suggestions for the improvement of these grazing areas are also given.

1. *Saccharum spontaneum*, Linn.

Tam.—*attu nanal.* Tel.—*rellu gaddi.*

Usually thrives near watercourses and in river-beds. It is a good sand binder. Buffaloes graze this grass. The leaves are used for thatching and sometimes as *darbha*.

2. *Eulalia phaeothrix*, O. Ktz.

It grows to 4′ in height. It is easily distinguished by the red-brown tomentum at the bases of the lower leaf sheaths. It is not considered a good fodder grass.

3. *Ischaemum aristatum*, Linn.

Tel.—*erruthotta gaddi*. Kan.—*mobbu ganjalu garikai hullu*.

It is a spreading grass and is considered a very good fodder grass. It thrives from sea-level to 8,000′.

4. *Sehima nervosum*, Stapf.

Kan.—*nalai hullu*. Tel.—*nendra gaddi*.

It is the best of the hill fodder grasses. It grows in very large clumps putting forth probably the largest number of tillers in any of the Indian grasses. It is rather difficult to get this grass established in a new locality. It thrives well in the plains if introduced. Cattle put on good condition if grazed on this grass. Generally it is confined to the higher reaches of the hills. It is seen associated with *Hardwickia binata* Roxb. and *Anogeissus latifolia* Wall. in this Forest Division.

5. *Lophopogon tridentatus*, Hack.

It grows to 1½′ in height. It thrives in very dry localities and is not considered a good fodder grass even though cattle nibble it before flowering.

6. *Capillipedium huegelii*, Stapf.

It grows to 2′ in height. It is a straggling grass and is not grazed by cattle being aromatic.

7. *Amphilophis pertusa*, Stapf.

Kan.—*karai kanda hullu*. Tam.—*chinna karai pullu*.

It is a very good pasture grass. It covers the ground by its slender creeping stems. Even though the output of forage is small it is considered one of the best fodder grasses. When the fertility of the soil gets diminished it gives room for *Heteropogon contortus*, Beauv. (spear grass).

8. *Vetiveria lawsoni,* Blat.
Kan.—*karai hullu* Tam.—*periya karai pullu.*

The flowering culms are almost devoid of leaves and are about 3′ to 4′ high. Buffaloes eat the culms while the cattle graze on the basal leafy portion. It is met with in the Kollegal plains and not in the hills.

9. *Sorghum halepense,* Pers.
Kan.—*kadu-kambu hullu.* Tam.—*kattu cholam.*

It grows to 6′ in height. It is considered a good fodder and hay grass when mature; when young, it is said to have injurious effects on animals eating it.

10. *Chrysopogon zeylanicus,* Thw.
Kan.—*bedi hullu.*

It is an erect grass but not considered a good fodder grass. Cattle, however, nibble it when young.

11. *Chrysopogon montanus,* Trin.
Tel.—*gurra batto kelu.*

It is one of the common grasses in the Kollegal Forest Division. It is gregarious in habit and is easily made out even from a distance on account of its golden colour. Cattle graze this readily but not relished much after flowering. It grows from $1\frac{1}{2}'$ to 2′ in height. The quantity of forage produced is not much.

12. *Heteropogon contortus,* Beauv.
Kan.—*sunkari hullu.* Tam.—*oosi pullu.* Eng.—spear grass.

Distribution: Sea-level to 7,500′.

It is the commonest fodder grass in this plateau. It is best relished by cattle before flowering. Cattle eat it readily also after the awns have dropped off. It is a hardy grass thriving in comparatively poor soil. It ousts other grasses in rocky and poor soils. It makes excellent hay and silage before flowering and also before the spikes mature.

13. *Themeda triandra,* Forsk.
Kan.—*thodda anji hullu.* Tam.—*erigai thattu pullu.*

It grows to 3′ in height. Eaten by cattle only when young. It is used for thatching.

14. *Themeda cymbaria,* Hack.

Kan.—*balai hullu.* Tam.—*noshia palai pullu.*

It grows to 6′ in height in large clumps. It is not a fodder grass. It is largely used for thatching.

15. *Apluda aristata,* Linn.

Kan.—*akku hullu.* Tam.—*manda pillu.*

It grows from 4′ to 5′ in height often scrambling over bushes and geniculate and rooting from the basal nodes. It is a fairly good fodder readily eaten by cattle, especially when young. There is a tendency for the stem to break off after the spikes have matured. It is seen in large patches in many localities especially in the Gundal Fuel Coupe in the Doddasampage Reserve forests.

16. *Eremopogon foveolatus,* Stapf.

It grows from 1½′ to 2′ in height. It is one of the best fodder grasses, but the yield of forage is not high because of the slender habit of the plant.

17. *Andropogon pumilus,* Roxb.

It grows to 1½′ in height. It is one of the best fodder grasses growing in large clumps. It stands cutting fairly well. It thrives best on black cotton soils.

18. *Cymbopogon flexuosus,* Wats.

Kan.—*authi bale.* Tam.—*sukhunari pullu.* Eng.—Malabar lemon grass.

It grows to 8′ in height. The stem will be often as thick as the little finger. It is cultivated extensively especially in Travancore for the extraction of "Malabar lemon grass" oil. It is used for thatching purposes also. It is unfit as a forage plant because of its strong odour. A white and a purplish form occurs.

19. *Cymbopogon confertiflorus,* Stapf.

It grows to 4′ in height. It is used for thatching purposes. Cattle do not graze it on account of its strong odour. It grows generally on rocky soils.

20. *Cymbopogon martini,* Wats.

Kan.—*kasi hullu.* Tam.—*kavattam pullu.*

It grows to 5′ in height. It is sometimes cultivated. The Indian *Geranium* oil or the *rusa* oil is extracted from this plant. Because of the strong odour the plant possesses it is not grazed by cattle.

21. *Cymbopogon gidarba,* Haines.

It grows to 4′ in height. This is the only Madras species of *Cymbopogon* which has no odour. Hence it is relished by cattle. A white and a purplish form occurs in this species which are seen side by side in the Gundal Fuel Coupe in the Doddasampage Reserve Forests. This grass should be encouraged to be grown in localities where it is not met with. It is sure to enhance the grazing value of the forests.

22. *Hackelochloa granularis,* O. Ktz.

Kan.—*kadu sanna harka hullu.*

It grows to 1½′ in height. It is a very rare grass in the plateau. It is a moderately good fodder.

23. *Digitaria marginata,* Link., var. *fimbriata,* Stapf.

Kan.—*henna akkibu hullu.* Tam.—*arisi pullu.*

It has a spreading habit. It is one of the best fodder grasses. It is met with in many Reserve Forests in the Kollegal Range but the quantity of forage produced is not much.

24. *Digitaria chinensis,* Horn.

It is a slender spreading grass growing in shady places near streams. It is a very rare grass in this plateau. It is grazed by cattle.

25. *Alloteropsis cimicina,* Stapf.

Kan.—*neru sajja hullu.*

It is an annual grass growing to 2′ in height. Cattle eat this grass readily. The quantity of fodder produced is not much. It is not reckoned as a good fodder grass because of its low yield and the annual nature.

26. *Brachiaria distachya,* Stapf.

Kan.—*hambu haraka hullu.*

It is a pasture grass spreading fairly well on the ground. It does not thrive in dry situations. The fodder produced is not much. Cattle graze it readily.

27. *Brachiaria ramosa,* Stapf.

Kan.—*kadu baragu hullu.* Tel.—*eduri gaddi.*

It grows to 2′ in height. It is an excellent fodder grass. It does not thrive in dry rocky soils. It is sometimes cultivated especially in Vizagapatam town for the grain which is made into cakes and eaten especially by Mohammedans. It is a rare grass in this plateau.

28. *Urochloa setigera,* Stapf.

It is a spreading grass thriving well in moist places. It is a rare plant in this plateau. It is an excellent fodder grass.

29. *Urochloa reptans,* Stapf.

Tam.—*shani pillu.*

It is a good fodder grass with spreading habit. The quantity of forage produced is not much. The grain is said to be eaten by the poor in times of scarcity.

30. *Echinochloa colona,* Link.

Tam.—*karumpul.* Tel.—*otha gaddi.*

It grows to 1½′ in height and is decumbent in habit. It thrives only in moist and rich soils. It is a very rare grass in this plateau. It is relished well by cattle. Grain is said to be eaten by the poorer classes.

31. *Oplismenus compositus,* Beauv.

Tel.—*konda anthirika gaddi.*

It is usually decumbent and rooting at the base. It grows to 1½′ in height. It thrives in moist and shady situations. It is grazed by cattle. It is a rare grass in this plateau.

32. *Panicum trypheron,* Schult.

Kan.—*kadu karai samai hullu.* Tam.—*samai-karunai.*

It grows to 2′ in height. It occurs in many parts of the plateau but it does not thrive in very dry situations. It is relished well by cattle but the quantity of forage produced is not much.

33. *Panicum antidotale,* Retz.

It grows from 6′ to 7′ in height. It was found growing near a stream in the North Burgur Reserve Forests. It is a very rare grass in this plateau. Cattle eat the leaves and reject the stem.

34. *Setaria pallidifusca,* Stapf. et Hub.

Tel.—*nakka kora.*

It grows to 1½′ in height. It grows from sea-level to 7,000′. It is a fair fodder. It is easily distinguished by the reddish-brown spikes.

35. *Setaria intermedia,* R. & S.

Kan.—*dodda anta parlai hullu.* Tel.—*aranki gaddi.*

It grows to 1½′ in height. It thrives in shady and moist places. Cattle eat it readily but cannot be reckoned a good fodder grass because of its annual nature.

36. *Setaria verticillata*, Beauv.

Kan.—*sanna anta parlai hullu*. Tel.—*chik lenta*.

It is an annual often rambling over bushes. Cattle graze on this before the spikes appear, and is not touched by them after the spikes appear because of the reversed barbs of the bristles of the involucre. The grain is said to be eaten by poorer classes.

37. *Cenchrus ciliaris*, Linn.

Tam.—*kolukkattai pullu*.

It grows to 2′ in height. It is an excellent fodder grass and is the mainstay of the Kangayam breed of cattle. It thrives in moderately dry situations. It stands cutting fairly well. It has given an aggregate acre yield of 41,520 lbs. of green fodder in three cuttings at Coimbatore. There are two races, one with straw coloured spikelets and the other with purplish spikelets. This was introduced in the Kollegal plateau a few years ago but not with great success.

38. *Arundo donax*, Linn.

It grows to 8′ in height and the hollow stem is as thick as the little finger. It grows along watercourses. Being a good sand binder it is often encouraged to grow along river banks where there is the fear of land erosion by current. It is not considered a good fodder. It is a rare plant in this plateau.

39. *Aristida depressa*, Retz.

Kan.—*kari sanna hanchi hullu*. Tam.—*kodai balla pullu*.

It is a very slender grass growing in dry situations. On account of its long awns on the spikes cattle do not relish it.

40. *Aristida setacea*, Retz.

Kan.—*dodda hanchi hullu*. Tam.—*thodappam pillu*.

It grows to 3′ in height. It is rejected by cattle on account of the long awns on the spikes. Used very largely for making brooms. It thrives in dry situations.

41. *Aristida hystrix*, Linn. f.

Kan.—*bili vunugada hullu*.

It grows to 2′ in height. It thrives in dry rocky soils. It is not considered a good fodder grass though it is said to be liked by cattle,

42. *Aristida funiculata,* Trin. et Rup.

Tel.—*kundeti gaddi.*

It grows to $1\frac{1}{2}'$ in height. It grows in masses in very dry situations. It is the most troublesome grass in the forest as the awns penetrate the skin of human beings. It is not touched by cattle because of its awns. It is often associated with *Randia dumetorum,* Lam. and *Rhus mysorensis,* Heyne.

43. *Trachys muricata,* Steudl.

It is an annual growing to $2'$ in height. It generally thrives in sea-shore sand but is also met with in other places. It is a very rare grass. Cattle relish this very much.

44. *Tragus biflorus,* Schult.

Tam.—*ottu pillu.*

It is a low spreading grass. The spiny spikelets stick to the mouth parts of cattle; hence the grass is not relished by them. It thrives in sandy and dry localities.

45. *Perotis latifolia,* O. Ktz.

Kan.—*nari measai hullu.* Tam.—*nari valpil.*

It grows to $1\frac{1}{2}'$ in height. It thrives in sea-shore sand and dry soils. It is a very slender grass having minimum vegetative portion. It is nibbled by cattle. It is an elegant grass with its long purple spikes.

46. *Sporobolus diander,* Beauv.

Kan.—*navalu dondi hullu.*

It thrives in shady places and often grows to $1\frac{1}{2}'$ in height. It generally occurs on the wayside. It is eaten by cattle and is not a very common grass in this plateau.

47. *Sporobolus wallichii,* Munro. et Hook. f.

Most of the leaves of this plant are confined to the basal portion. It is a shade-loving grass. It is eaten by cattle but the fodder produced is not much.

48. *Eragrostis plumosa,* Link.

Kan.—*sanna purlai hullu.* Tel.—*chinna garikai gaddi.*

It grows in masses in some localities, especially near Girgaigandi Forest Rest House. It grows to $1'$ in height. It is a slender grass eaten by cattle but the fodder produced is not much.

49. *Eragrostis diarrhena,* Steudl., var. *koenigii.,* Stapf.

It grows to 3′ in height. It thrives in moist situations. It is an annual and rare in this plateau. It is relished well by cattle.

50. *Eragrostis cilianensis,* Link.

Kan.—*bettada akabu hullu.*

It grows to 2′ in height. It does not thrive in very dry situations. It is an annual, readily eaten by cattle, and is rare in this plateau.

51. *Eragrostis tremula,* Hochst.

It grows to $2\frac{1}{2}'$ in height. It is a good fodder grass, but the foliage is too scanty to yield much substance. The seeds are sometimes said to be eaten by the poor.

52. *Eragrostis willdenoviana,* Nees.

Kan.—*kari jontu hullu.*

It grows to $1\frac{1}{2}'$ in height. Cattle do not relish this grass much owing to its peculiar odour. However it is nibbled by them.

53. *Eragrostis nigra,* Nees.

It grows from 1′ to 2′ in height. It thrives from 2,000′ to 7,000′ in height. It is confined to the higher reaches of the Doddasampage Reserve Forests in this Forest Division. It is grazed by cattle.

54. *Eragrostis bifaria,* Wt.

Kan.—*kodi mara hullu.* Tel.—*gubbikal gaddi.*

It grows to $1\frac{1}{2}'$ in height. Cattle graze on this but the fodder produced is very little as the leaves are very minute. It is characteristic of very poor and dry soil. It is associated with *Randia dumetorum,* Lam. and *Rhus mysorensis,* Heyne., etc., in this plateau.

55. *Eragrostis brachyphylla,* Stapf.

It grows to 1′ in height. The yield of forage is very little like *E. bifaria,* Wt. and also is characteristic of dry and poor soil. It is a rare grass in this plateau.

56. *Oropetium thomaeum,* Trin.

It is a dwarf plant growing to about 4″ in height forming hard tussocks. It occurs in dry localities. The spikes are longer than the stems. Cattle may graze on this. It is a rare plant in this Forest Division.

57. *Enteropogon monostachyos,* K. Sch.

Tam.—*kannai pillu.*

It is a tall slender grass growing to 3′ in height. It is generally

seen in bushes in this division. It thrives in dry situations. Though it is a hill-grass it can be easily acclimatized in the plains. It has been found by analysis that this grass has very high nutritive value. It is one of the best fodder grasses giving an aggregate acre yield of 17,840 lbs. of green fodder in three cuttings at Coimbatore. This grass should be encouraged to be grown wherever it is absent in this Forest Division.

58. *Cynodon dactylon*, Pers. (The Common *Hariali*).

Tam.—*Arugam pillu*. Kan.—*kudi garikai*. Tel.—*gericha gaddi*.

It is one of the best pasture grasses and it makes excellent lawns. It is a highly nutritious fodder especially for horses. It grows to 1′ in height. It spreads by the underground stems. It is a pernicious weed in arable land and is eradicated with great difficulty. It grows from sea-level to 7,000′. It is a very rare grass in this plateau.

59. *Cynodon barberi*, Rang. & Tad.

Kan.—*mel garika hullu*.

It grows to 9″ in height. It is a pasture grass but has no underground stems as in *C. dactylon*, Pers. It grows in dry situations. It is a good fodder grass but the output of forage is not heavy. It is a common grass in this plateau.

60. *Chloris incompleta*, Roth.

Tel.—*kanthari gaddi*. Kan.—*melamalai hullu*.

It grows to 1½′ in height often in hedges and scrambling among bushes. Eaten by cattle before flowering.

61. *Chloris barbata*, Sw.

Tam.—*kuruttu pullu*. Kan.—*hennu manjada kalu hullu*.

It grows to 1½′ in height. It does not thrive in dry and rocky soils. It is a very rare grass in this plateau. It is a good fodder grass. It thrives even in alkaline soils.

62. *Chloris bournei*, Rang. & Tad.

Tam.—*Periya kuruttu pullu*.

It grows to 2′ in height. It is a good pasture grass. The main stem creeps along the ground and roots at the nodes thereby covering the entire ground. It is a very good fodder grass. It gave an aggregate acre yield of 56,560 lbs. of green fodder in four cuttings at Coimbatore when grown under irrigated conditions. It is a rare grass in this division.

63. *Dactyloctenium aegyptium*, Beauv.

It is an annual which creeps on the ground and rooting at the basal nodes. Cattle graze this readily. It does not thrive in poor and rocky soils.

64. *Dendrocalamus strictus*, Nees.

Tel.—*sadanappa veduru*. Tam.—*kal mungil*.

It grows to 30′ in height. It has no thorns. The culms are much used for poles, rafters, lathis, matting, baskets, etc. It has no fodder value.

65. *Bambusa arundinacea*, *Willd.*

Tel.—*veduru*. Kan.—*dongi*. Tam.—*periya mungil*.

It grows to 60′ in height. It is thorny. The culms are used for buildings, scaffoldings, mats, baskets, etc. It has no fodder value. The tender shoots are used in pickle-making.

A few suggestions for the improvement of the grazing areas in the Kollegal Forest Division:

1. *Sehima nervosum*, Stapf. May be introduced in hilly areas wherever it is absent.

2. *Cymbopogon gidarba*, Haines., *Andropogon pumilus*, Roxb., *Eremopogon foveolatus*, Stapf., *Amphilophis pertusa*, Stapf., *Enteropogon monostachyos*, K. Sch., etc., may be tried in all localities where they are absent.

3. Grasses like *Chionachne koenigii*, Thw., *Leptochloa obtusiflora*, Hochst., *Iseilema laxum*, Hack., etc., which are absent in this Forest Division, may be introduced in suitable localities.

Grass seeds may be collected in the month of December and sown a month before the commencement of the north-east monsoon.

Cattle may be allowed to graze only after the spikes have matured and dropped their seeds wherever the grasses are sparse.

TIMBER PRICE LIST, MAY-JUNE 1938

(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Assam ..	Logs ..	Rs. 30-0-0 per ton in Calcutta.
Benteak ..	*Lagerstrœmia lanceolata*	Bombay ..	Squares ..	Rs. 40-0-0 to 80-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-4-0 per c.ft.
Bijasal ..	*Pterocarpus marsupium*	Bombay ..	Logs ..	Rs. 46-0-0 to 84-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-6-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-6-0 to 0-15-0 per c. ft.
Blue pine ..	*Pinus excelsa* ..	N. W. F. P.	12′×10″×5″ ..	Rs. 4-10-0 per piece.
,, ..	,, ..	Punjab ..	12′×10″×5″ ..	Rs. 4-13-0 per piece.
Chir ..	*Pinus longifolia* ..	N. W. F. P.	9′×10″×5″ ..	Rs. 1-15-0 per piece.
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	
,, ..	,, ..	U. P. ..	9′×10″×5″ ..	Rs. 3-4-0 per sleeper.
Civit ..	*Swintonia floribunda* ..	Bengal ..	Logs ..	Rs. 25-0-0 per ton.
Deodar ..	*Cedrus deodara* ..	Jhelum ..	Logs ..	
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	Rs. 4-0-0 per piece.
Dhupa ..	*Vateria indica* ..	Madras ..	Logs ..	
Fir ..	*Abies & Picea* spp. ..	Punjab ..	9′×10″×5″ ..	
Gamari ..	*Gmelina arborea* ..	Orissa ..	Logs ..	Rs. 0-10-0 to 1-4-0 per c.ft.
Gurjan ..	*Dipterocarpus* spp. ..	Andamans ..	Squares ..	
,, ..	,, ..	Assam ..	Squares ..	Rs. 50-0-0 per ton.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 30-0-0 to 35-0-0 per ton.
Haldu ..	*Adina cordifolia* ..	Assam ..	Squares ..	Rs. 1-2-0 per c.ft.
,, ..	,, ..	Bombay ..	Squares ..	Rs. 28-0-0 to 68-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-13-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-3-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-9-0 per c.ft.
Hopea ..	*Hopea parviflora* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Indian rosewood ..	*Dalbergia latifolia* ..	Bombay ..	Logs ..	Rs. 54-0-0 to 100-0-0 per ton.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-12-0 to 1-4-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 2-2-5 to 3-12-0 per c.ft.
Irul ..	*Xylia xylocarpa* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Kindal ..	*Terminalia paniculata* ..	Madras ..	Logs ..	Rs. 1-4-0 to 1-5-6 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 50-0-0 to 72-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-10-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-12-1 to 0-14-2 per c.ft.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	Rs. 1-2-9 to 3-14-0 per piece.
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 50-0-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-3-0 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 20-0-0 to 75-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Rs. 0-8-0 to 1-3-0 per c.ft.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 to 5-0-0 per sleeper.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 1-10-0 per sleeper.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-0-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-0-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-14-3 to 5-4-0 per sleeper.
Sandalwood	*Santalum album* ..	Madras ..	Billets ..	Rs. 325-0-0 to 890-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Rs. 1-8-0 to 1-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-6-0 to 1-0-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 30-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	Rs. 1-0-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Rs. 0-12-1 to 1-1-10 per piece.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-0-0 to 1-6-6 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class	
,, ..	,, ..	,, ..	Logs 2nd class	
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-9-9 per c.ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 2-3-3 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-13-11 to 2-15-0 per c.ft.
,, ..	,, ..	Bombay ..	Logs ..	
,, ..	,, ..	,, ..	M. G. sleepers	
White dhup.	*Canarium euphyllum* ..	Andamans ..	Logs ..	

REVIEWS

ANNUAL REPORT ON FOREST ADMINISTRATION IN BURMA, 1936-37

This Annual Report from Burma follows the usual stereotyped form, with 50 pages of reading matter and 180 pages of forms. The life of a Forest Officer may now well be described as "one d——d form after another."

The financial results of the year under review were good. The revenue was Rs. 1,42,64,626, as against Rs. 1,33,08,654 for 1935-36. The expenditure, on the other hand, was only a little over one lakh more than in the previous year. The surplus was Rs. 87,24,410, as against Rs. 78,89,128 in 1935-36. The percentage of net revenue to gross revenue was 61.16 per cent, the highest recorded since 1920-21. This high figure was due, in the main, to the low expenditure figure as compared with the pre-slump years.

In Silvicultural Research the chief new work of the year was the laying out of a large number of experimental plots in areas where *Bambusa polymorpha* had flowered. These were designed to determine whether teak could be successfully introduced into such areas by planting root and shoot cuttings and by broadcasting seed. Later, it transpired that the cuttings had succeeded fairly well but that the broadcasting of seed had produced no results, although a lot of fertile seed still remained on the ground. Further experiments with teak stumps confirmed previous observations that the faster growth of plants from stumps disappears in the third year, when compared with direct-sown seed and transplants.

In Forest Entomology, studies on the bee-hole borer were continued, and arrangements for the interchange of parasites of teak defoliators between Burma and Madras were put into effect before the close of the year.

In Utilisation, the starting of a series of controlled tests on different wood preservatives was inaugurated at Rangoon and Pyinmana. The end-coating of teak logs with various end-coating mixtures and an investigation into the control of matchwood supplies were also undertaken.

The Report is well illustrated with five good photographs of silvicultural interest and animals in Pidaung game reserve.

THE PUNJAB FOREST ADMINISTRATION REPORTS FOR THE YEARS 1934-35 AND 1935-36

The Punjab Administration Reports for the two financial years 1934-35 and 1935-36 have both appeared in print at the same time and so it will be convenient to review them together. In this connection it may be observed that one of the reports has appeared 18 months after it should normally appear.

In the Himalayan forest belt 6,000′ to 12,000′ the management of the valuable deodar, blue pine—fir forests continues satisfactory. The so-called Punjab Shelterwood method which permits shelterwood and selection principles of regeneration to be followed indiscriminately in the Regeneration block continues to give very good results: regeneration is well above normal except in the fir forests where a poor demand for the timber has prevented seeding fellings being made to the extent laid down in working plans. With a sale price at Doraha and Dhilwan of only 9 to 10 annas per cubic foot for fir, it is impossible to utilise the vast areas of fir and spruce the Province possesses.

In the Lower hills 3,000′ to 7,000′, the chief problem at the moment is the control of erosion. The problem has been talked about for years, but very little done about it. 1934 was, however, notable for the beginning of a really serious attempt to check this dangerous nuisance. Mr. A. P. F. Hamilton, M.C., was placed on special duty in the Hoshiarpur Siwaliks and by his active, keen and arduous propaganda he has succeeded in inducing villagers to close *voluntarily* some 55,000 acres of overgrazed hillsides. And this was not possible of course until he had first demonstrated and made them realise the value of the grass crop in the closed areas. The Research Division is also co-operating and has established a special nursery at Nurpur devoted to the study of grasses and plants required for counter-erosion in badly denuded areas, and Demonstration areas to show how badly eroded land can best be reclaimed and utilised. It has also added erosion to the triennial programme of research and is to collect figures of run-off and soil losses on various classes of land.

Owing to high freightage charges and the very low price of rosin in foreign markets the collection of crude resin was still further

reduced. In 1930-31, 70,610 maunds were collected; in 1933-34, 47,524 maunds; in 1934-35, 39,137 maunds and in 1935-36, 35,429 maunds—nearly 50 per cent. reduction in the last five years. On Government capital the Jallo concern paid 6.2 per cent. in 1935-36 against 6.5 per cent. in 1934-35.

The famous irrigated plantations of the Province continue to bring in a large part of the revenue. There was a general improvement in the fuel market, prices for shisham rising from Rs. 10-9-0 per 100 cubic feet in 1933-34 to Rs. 13-8-0 in 1935-36. The annual yield from the irrigated plantations is now about 5½ million cubic feet of fuel and 110,000 cubic feet of timber.

The financial results are not easy to determine. There was a cash deficit of Rs. 3,00,466 in 1934-35 and Rs. 2,38,544 in 1935-36 but, as the Chief Conservator points out, the expenditure figures each year include nearly 4 lakhs of rupees spent for the benefit of third parties and the revenue figures take no account of over 25 lakhs of rupees worth of forest produce given free or at reduced rates to right-holders.

G. D. K.

FODDER GRASSES

(1) INDIAN GRAZING CONDITIONS AND THE MINERAL CONTENTS OF SOME INDIAN FODDERS

BY P. E. LANDER, M.A., D.SC., F.I.C., I.A.S.,

Agricultural Chemist to Government, Punjab, Lyallpur.

(*The Imperial Council of Agricultural Research Misc. Bull. No.* 16, 1937, *Rs.* 3-14-0, *Government of India Press, New Delhi.*)

The author has been at work for several years on the nutritional and chemical values of local fodders, both cultivated and uncultivated. It is naturally the latter class that is of interest to forest officers and some insight can be gained from this study of grasses. The wild fodder grasses are tending to become of financial importance in many

forest reserves which are incapable of producing much timber or fuel, and in many of the dry *rakh* jungles grass production is of prime importance to the community though it may not yield any cash return to the various departments responsible for such areas. Most foresters have regarded grass as being very definitely a minor product, but with an increasing demand for dairy produce and attention to human and animal nutrition, grass is bound to take a much more important place in future. Grass-land, speaking generally, has been "nobody's child" and many foresters still think that its management and improvement is no business of ours. On the other hand, no other department of Government is in any better position to take it on, and it seems as if the proper management of uncultivated grazing lands will in most provinces be forced upon us simply because there is no other body more capable of undertaking it. As foresters we must therefore be prepared to take more interest in this subject than most of us have taken in the past.

This publication is to a great extent a compilation of previously published data, but as most of these publications are not accessible to the ordinary forest officer it is well to have the information brought together. This includes a summary of forest grazing conditions in the various provinces previously prepared as an editorial for the *Indian Forester* (March 1933); particulars of the soil requirements and fodder values of some Punjab grasses prepared many years ago by Col. W. Coldstream, a Punjab civilian; and information published by the author between 1929 and 1932 in agricultural journals on the nutritive value of Kangra rice straw and of various hay samples from Military Grass Farms and Remount Depots. Fresh data now given from subsequent work at Lyallpur justify a number of conclusions of which the following is a summary:

(*a*) There is probably a direct relationship between the mineral contents such as phosphoric acid and the amount of digestible protein, and both these items are seriously deficient in the grass of the foot hill grazing grounds. The mineral factor is a most important one particularly for young growing animals.

(*b*) Many of the foothill grass samples indicate such a poor digestibility rate that even the small amounts of important mineral foods cannot be assimilated.

(*c*) Grasses such as *anjan* (*Pennisetum cenchroides*) grown on irrigated or inundated land gives a much higher protein and mineral ration than the same grass on drier ground. (This indicates a need for some form of water conservation practice such as contour ridging on all sloping land.)

(*d*) All figures available go to prove statistically what we already know about the wild fodders, mainly that they deteriorate seriously in food value and palatability if harvesting is delayed long after flowering. (Unfortunately the cultivator is generally busy with his autumn ploughing just when the grass ought to be cut, so the grass is left till later and deteriorates in consequence. This again points to the need for some form of water conservation which would tend to prolong the growing season of the grass and delay its withering.)

(*e*) Measurements of iodine content show a marked deficit from samples from hill tracts notorious as centres for goitre, which is known to be due to deficiency of iodine.

(*f*) Only the fringe of this large subject has been touched by the small amount of research so far done and a vast field of work awaits to be done on grassland improvement.

(2) *Punjab Fodder Grasses.*—Grass Farm Manual, Government of India Press. Not for sale.

This contains a great deal of useful information about the reclamation and improvement of wild grass lands; the cutting and preparation of hay; stacking and baling of fodder; ensilage; etc. The most useful section, however, from the foresters' point of view is the one on grasses. Each of the common grasses is listed and its various local names given as was done originally in Duthie's "Fodder Grasses of Northern India" which unfortunately is now out of print and unobtainable in the market. The difficulty of connecting the local vernacular name with the correct botanical identification is even greater than in Duthie's day owing to recent sub-division of genera and uncertainty as to the botanical names now accepted for certain plants. There is also a discussion of each grass with notes on its distribution, methods of cultivation, fodder value, etc.

R. M. G.

EXTRACTS

U. S. RESEARCH LEADS BATTLE TO FIND NEW USES FOR WOOD

Because forestry is responsible to the American people for the productive use of hundreds of millions of acres of land, every day's development at the United States Forest Products laboratory here play major roles in the drama of human welfare.

Whereas the chief purpose of the United States Forest Service, of which the laboratory is a part, in restoring and developing forests on those vast land areas which agriculture does not need, is to make them contribute their share to the secure and permanent support of the country's population, it is the laboratory's special task to aid in enhancing the value and utility of the innumerable products which the forests can supply.

Since establishment in 1910 of the laboratory, the only institution of its kind in the country and the largest in the world, its research in evolving new and useful items from wood has been of the utmost importance to Mr. and Mrs. Average Citizen, whose housing and living standards are bound up with a continuing supply and satisfactory use of wood products; to the workman who needs the $1,000,000,000 worth of employment given by the sawmill, the pulp mill, and wood manufacturers; to the farmer with his 125,000,000 acres of woodlands; to local communities, counties, states and the nation, into whose exchequers flow stable revenues from forests and successful forest enterprises.

600,000 Tests Made

To the end of adapting wood more effectively to its uses, the laboratory has made more than 600,000 mechanical tests to determine the strength characteristics of more than 160 native woods. As a result of boxing and crating investigations alone, claims against railroads for damage to goods in transit were reduced $37,000,000 in a single decade.

Although in recent years wood construction has lagged and other materials for building homes, stores, farmsteads and factories have come in more than half the wood cut from the forests still goes into

building. But mills have closed, thousands of forest workers have been thrown out of employment and potential forest areas lie idle, while the need for homes and buildings never was greater. Hence the laboratory is preparing wood to meet modern construction requirements. Incredible as it sounds, it took seven men exactly 21 hours to erect a model pre-fabricated all-wood demonstration house at the laboratory. Built of factory-made plywood panels, the house, proven as sturdy as the best of the conventionally built homes of to-day, could be duplicated for about $2,000.

Not only in the modern but in the pioneer tempo of building does the laboratory point a new way. Utilizing not whole, but split logs, placed not horizontally in the traditional manner but vertically, it has shown how to build a year-round log cabin for as little as $450 for material in addition to the short rough timbers farmers or vacationists often can cut from their own cutover land, tamarack and cedar swamps, and from second-growth which never will be of commercial use.

The laboratory's conception and testing of large laminated arches composed of small pieces of wood glued together has made it possible for wood to enter competitively and advantageously into the design of modern buildings requiring large clear spans, such as auditoriums, gymnasiums, and industrial plants.

Wood shrinks as it seasons or dries, and since uncontrolled shrinkage causes checks and splits, cupping and warping, steps must be taken to avoid such damage. Seasoning processes developed at the laboratory are estimated to save American wood users $10,000,000 annually in better lumber and fabricated products. Ten of the most completely equipped dry kilns ever installed for experimental service are a part of the laboratory's equipment.

With premature decay causing losses to unprotected wood in service equal to the destruction annually resulting from forest fires, research with preservatives at the laboratory is of no mean importance. As a result of exposure tests of painted panels throughout the country, the laboratory has perfected methods which in many cases will double the life of an outdoor paint job. Discovery of exact causes and effects of moisture accumulation in house walls and roofs promises to overcome or avoid damage to the wall itself and to the exterior paint and interior decoration.

Noteworthy strides have been taken in showing how to produce white papers from our own southern pines; in converting wood waste into paper and boards; in testing more than 100 American woods as pulp and paper material. Great is this service in view of the millions of tons of pulp and paper imported annually, while millions of cords of native woods go to waste with no return in products or employment.

Application of knowledge gained by the institution's studies of planting, pruning and thinning forests in the future will enable the grower to lend nature a hand in producing the kind of wood he wants, whether hard or soft texture, heavy or light weight, and in determining, in advance of cutting, the extent of knots within a tree which are responsible for serious drop in lumber grade.

Moreover, an average of 3,000 times each year the laboratory's positive identification of a few chips of wood shavings, sawdust or wood flour settles important questions of commercial use, safeguards consumers against unscrupulous manufacturers, or proves innocence or guilt in criminal cases.—(*Christian Science Monitor.*)

THE MAN-MADE DESERT IN AFRICA—EROSION AND DROUGHT

By Professor E. P. Stebbing

(*Continued from pp. 382—393 in June 1938 number.*)

THE ANNUAL FIRING OF THE COUNTRYSIDE

A large part of occupied Africa is burnt over annually. To the man in the street this will seem a rather extraordinary statement. But it may be explained that this firing of the countryside is bound up with, or is one of the sidelines developing from, the agricultural custom in force throughout much of the country, cultivation by the method known as shifting cultivation.

When the British Administration gradually spread throughout India, shifting cultivation was practised by the people in many of the forested parts of the country, accompanied, as is the usual practice, by firing the countryside, either intentionally or letting the fire spread from the area burnt over by the shifting cultivator. By the end of the first half of last century the loss involved by the practice of the shifting cultivator on both counts was seen to be detrimental to the well-being of the country and the community. At the end

of the century, shifting cultivation had long ceased in British India, except in a few localities where it was, and is still, under regulation; whilst the annual promiscuous firing of the countryside had ceased under the law. The forests under conservation, of one type or another, were protected from fire by the maintenance of cleared boundary lines and, where necessary, specially cut fire traces; whilst out in the districts, main roads and camping spots were annually fire-traced by having cleared lines on either side or round them, so as to regulate and prevent the spread of such fires as were lit in the ordinary course of agricultural work.

In Africa much of the cultivation is a form of shifting cultivation dependent upon the felling and burning of a forest crop, however degraded the latter; these fires are lit in the hot season and spread to the surrounding bush country, being assisted by the action of hunters in setting fire to areas of bush in order to get rid of the dead grass and thus facilitate hunting. In the stock-raising parts the bush is burnt also to get rid of the old dead grass, thus permitting the animals to feed upon the new young grass sprouting with the first falls of the rainy season.

It may be suggested that the steps by which India put an end to this promiscuous firing of the countryside could be taken in Africa in each district, by the Political Officer prohibiting the indiscriminate firing of the degraded forest areas (bush) and by restricting the firing, where necessary for cultivation and so forth, by ordering the cutting and clearing of fire lines or traces laid down in the necessary direction and of suitable width to ensure the attainment of the desired object. The mere fact of the introduction of such a procedure to be carried out by the villagers themselves within their own jurisdiction would gradually educate the Native to appreciate the beneficial results which such protection brings in its train.

When fire protection was first introduced into India there were plenty to prophecy, both European and Indian, that the attempt was foredoomed to failure. They were wrong! And by degrees a net-work of fire-protective lines spread throughout those parts of the country where their presence proved necessary. And the reasons for fire-protecting main roads, camping grounds, and so forth during the hot season throughout the country became in time perfectly understood.

FARMING AND ITS ROTATION AND PASTURING OF STOCK

It would appear that some form of check is required on the at present, it is understood, mostly unregulated farming rotation in force amongst the people. Since this farming is mainly dependent upon the presence of forest on the ground it appears necessary to know what part of the district is actually farmed and the total area within the district thus farmed. This, with the area of the district known, would give the area of unfarmed countryside used for other purposes, leading often to erosion. Moreover, these figures would enable the actual rotation of farming the same piece of bush to be known throughout the district.

Land hunger is making itself felt in parts of Africa. The shortness of the rotation, *i.e.*, periods between visits to a particular area (I saw areas down to four years in parts of Sierra Leone) is obviously a criterion by which the prosperity and position of the district from the point of view of over-utilisation of the soil and erosion and its dangers can be judged, so long as shifting cultivation is the main form of crop culture. And consequently the protective measures which may appear desirable to introduce in a near future.

In the case of districts where stock is the chief concern of the village, figures in a district are probably available to show the head of stock per unit of area; a knowledge is required as to what the area produces in the way of food and whether this production is sufficient for the head grazed; or whether it is becoming deficient through excess grazing, erosion and consequent soil deterioration. Whether at certain seasons outside stock comes into the district for grazing purposes, and how such an invasion affects the amount of subsistence available both for the existing stock of the district and that of the invading herds; and how both react on the existing supplies.

What practical steps have been, or can be, taken in the district to regulate this grazing when it is known to be in excess resulting in serious degradation of the soil values and erosion which is reducing the area so occupied to a barren unproductive state.

WATER SUPPLIES AND THEIR DECREASE

Apart from excellent work carried out in certain parts of Africa in the investigation of water supplies and rainfall statistics, the question, with reference to water, of practical importance for the

district, is to endeavour to assess the differences which exist, or may exist, in the amount of water available at the present day for the requirements of the population, compared with a decade or two ago. Since both population and, where present, stock may have greatly increased, more water will be used and it may not prove easy to obtain reliable figures. But where water supplies in a tropical and sub-tropical country are under consideration, a study of existing springs, streams, rivers, and wells, will afford, as has been already shown, plentiful evidence of a decrease, if present.

A certain amount of evidence on the subject of protective measures undertaken in India during the past century to combat and ameliorate the position reached in parts of the country, owing to over-utilisation of the forest and soils with resulting erosion and injury to the water supplies, is available. This evidence also sheds some light on what happens to the rainfall when serious erosion is well under way in a certain type of country. By the end of last century the following information was available in India.

The influence of continued protection on the continuity and supply of water in springs, tanks (dry valleys or depressions across the outlet of which a bund or wall was built to hold up the water), and wells showed the most divergent results. In some places a continuity and regular supply of water followed protective measures, whereas in others an immediate decrease of the water supply took place. These phenomena had been foreseen. In the case of the tank, for instance, where the maintenance of the water level depended upon a rapid flow into it, which resulted from rain-water falling upon and rapidly running off a bare piece of ground, a covering of vegetation on the area naturally interfered with this rapid flow and the level of the water dropped. The tank had been built to replace the dried-up streams and springs formerly existing on the area when it was covered with vegetation. These streams provided, naturally, moisture to the area which now had to be irrigated by raising the water from the tank by the labour of man and distributing it over the land. In the case of protective measures introduced with the object of restoring the natural water supplies, time is required before the sub-surface flow of water can regain its proper level, and the experiments made up to this time were still too recent to afford reliable results. An investigation had shown, however, that water had already been found near

the fire-protected Danta Forest Reserve in Ajmere at a depth of 15 feet, whereas under very similar conditions as regards rock, stratification and soil but where the hillsides were bare of vegetation, water was not reached under a depth of 25 feet.

The measures of protection above alluded to were chiefly fire-protecting the areas concerned and excluding all grazing animals.

Where a scattered scrub jungle still existed the hillsides, protected from fire and grazing, with, if necessary, some artificial assistance, became reclothed with vegetation in an extraordinary short space of time.

Most of the expert opinion on Africa is agreed that it is the over-utilisation of the vegetable covering of the soil which commences the reduction of water supplies and the lowering of the water table in the soil. Since apart from rainfall the people depend for the major part of their water on springs, streams, rivers, and wells it is now well known that it is imperative that the catchment areas of these sources of supply should be kept under a certain protection of forest.

On this question of water supplies it is apparent, therefore, that for Africa, district by district, a statement is required showing the exact position of springs, streams, and rivers (and how protected at their catchment areas), and indicating what springs have dried up within man's memory whether the streams and smaller rivers run dry in the hot season or have the water restricted to a number of disconnected pools; the difference between the cold weather and wet season height in the level of the larger rivers and the extent of the channel of the river covered by the water in the cold and hot seasons of the year; and, finally, in the district dependent upon wells for the water supplies, the depths of water level in the wells, and whether it has shown signs of falling.

With this information available for a series of districts covering the hilly and level portions of a particular region it should not be difficult to ascertain the true position of its water supplies and what decrease, if any, is taking place.

EROSION AND INTERMITTENT RAINFALL

On the subject of the Intermittency in Rainfall which continued erosion brings in its train, it has been stated that a period arises under all types of erosion when the normal rainfall for the region commences to become interrupted. This interruption has in the

past made its appearance very slowly and at a rate almost imperceptible to man.

In its initial stages it has been alluded to as drought; and for a varying space of years it is correctly so designated. For, in its incipient stages, interruptions in the rainfall have been followed by normal years. In the past with the far smaller populations these alternations must have been spread over considerable periods of time. Nowadays, this stage in rainfall supplies arrives infinitely quicker, as is instanced by the comparatively short period of years in which the Dust Bowls of the United States and Canada and the soil drift of Southern Australia have been produced.

Once the rainfall has reached the Intermittent Stage, it is held *that if the methods under which this intermittency* was brought about are continued the interruptions in rainfall will gradually become longer and longer, until so far as the amounts received annually are concerned, they cease to be of any utility to man.

It is considered possible that investigations should show for each district in all areas subject to erosion the stage in the intermittency of rainfall supplies which has been reached. With this information, and for the particular type of erosion in force, it should prove feasible if the stage reached has not gone far beyond what is termed the Intermittent Stage, to prescribe remedial measures with the object of restoring soil values and the former prosperity of the region. The *stoppage or strict regulation of firing the countryside is one of the* first; a second, a regulated rotation farming; closing as large an area of the "bush" to over-grazing, hunting and promiscuous hacking, and, of course, protecting it from fire; and protection and afforestation work in badly eroded areas. All, save the last, are fairly easy methods which yield quick and probably quite startling results on the countryside; and infinitely cheaper than expensive public works which, though storing up water, will not protect the origin of the supplies.

RESEARCH

It is known that research work has already been inaugurated in connection with erosion. In Kenya, Tanganyika, Uganda and Nyassaland, officers are engaged in making surveys of erosion areas. In Nigeria the work has been commenced in the north. French officers have also been engaged in investigations on this matter.

The research work in the first instance requires, it may be suggested, to be mainly confined to water supplies. This investigation will assist the district officer, once he has provided himself with a tabular statement showing the areas of erosion in various degrees in his district. For those who think that too much is being made of erosion and its consequent effect on water supplies in Africa, research work which enables the exact position of the latter in the country to be known, will at the same time demonstrate, without doubt, the effect on them which the past and present methods of agriculture have had.

In the Anglo-Egyptian Sudan, where pasturage is an important item in the economy of the people, research work is, I understand, being undertaken into the local grasses with the ultimate object of, if possible, improving the grazing areas; which would mean a possibility of either restricting the area grazed or safely increasing the head of stock maintained.

It is scarcely possible to discuss erosion in Africa without alluding to the operation being undertaken by the Medical Authorities with the object of the eradication of the tsetse-fly. To those who have given some study to erosion and its dangers, the clear felling of trees and undergrowth along the banks of rivers and the complete clearance of vegetation round towns and on either side of caravan routes, fire being made use of to ensure the total extermination of trees and plants, must have come as a shock when seen on the ground for the first time. These operations are undertaken to prevent the spread of the flies which harbour in the undergrowth.

It is too soon to say what effects this destruction of vegetation in a tropical country will have on water supplies and the water table. But a study of the clearance of forest in the interest of agriculture on the scarp, and the clearance of all vegetation round the town of Kumasi, in Ashanti, Gold Coast, caused one to speculate as to the effect these operations of man would have on the water supplies of the fine new reservoir recently completed to supply the town.

I have had the opportunity of reading the report by Mr. J. L. Stewart, Director of Veterinary Services, Gold Coast ("The

Eradication of tsetse-flies of the *G. palpalis* group from the Pong-Tamale Area, Northern Territories, Gold Coast, 1937") and have discussed this matter and erosion generally with him. The report brings out a valuable point, based on a piece of research. Is it necessary or even a correct procedure in the interest of the region concerned, to clear fell, and eradicate all vegetation with the object of preventing or restricting the movements of the tsetse-fly? Cannot the big trees be left? And in how far can erosion be minimised when these operations are carried out by sparing the big trees?

In dealing with this matter, Mr. Stewart shows that many of the African streams and rivers in areas which are being treated for tsetse are slow-running, and therefore the clearance of vegetation may not be dangerous. Writing of the Pong-Tamale Area in the Northern Territories of the Gold Coast, where a new veterinary station was built in 1930-31, comprising laboratory, headquarters, and farm, he says—

> "The Naboggo River and its tributaries are slow-running streams which meander. Nevertheless, at certain points there is rapid flow at the height of the floods. Though all low shade trees have been removed from the actual banks of the river, wherever possible high shade trees have been left, particularly *Daniellia oliveri*. Many stretches of river exist with no trees on the banks, and it was in these reaches that alarm was felt about erosion and it was even thought that the river might change its course as a result of clearing. These fears have proved groundless. It has not been necessary to adopt any anti-erosion measures because usually such a profuse growth of grass has occurred in the banks that there has been no more erosion than before clearing. A thick carpet of *portulaca* has appeared in the odd spots where grass is not profuse. In the event of erosion on the banks of streams similarly cleared, the planting of high trees in avenue form along the banks of rivers is quite feasible. *Daniellia, Diospyros, Eucalyptus, Albizzia, Vitex cienkowski, Pterocarpur erinaceus, Pseudocedrela, Terminalia, Khaya senegalensis* and possibly *Isoberlinia* are suggested as likely to be successful."

On this important matter, far from the point of view of erosion, even if we omit the equally essential one of shade and amenity in a hot climate, the research work carried out by Mr. Stewart at Pong-Tamale in connection with the question of refraining from felling the

high shade trees appears to be of the highest value. In his report he writes:—

"The question of retention or otherwise of high shade trees in or near tsetse clearings has been the subject of controversy in this country. In consequence, considerable care has been taken at Pong-Tamale with a view to obtaining definite information thereon. In up-country clearings, many large trees, mainly *Danielliæ,* had been cut down and the disposal of their trunks which usually littered the banks of river-beds, was an obvious problem. At Pong-Tamale, practically no trees of this description have been cut and in smaller clearings made by the department, these trees have also been left *in situ*. Five years' continuous observation has failed to produce a single case of pupation under the cover of a high shade tree. By a high shade tree is meant a tree with a clean bole up to ten feet from the ground, no branches coming below that level. The principal high shade trees have already been enumerated, but the predominant high shade tree in all Northern Territories, rivers and swamp areas is undoubtedly *Danielliæ oliveri* and most of the observations here have been carried out in connection with this tree. It has a clean bole usually for more than ten feet, a straight light-grey stem, generally tapering in form, and a triangular crown with a flat top. It has been found that tsetse-flies of the *palpalis* group are frequently found below such trees during the early rains from June to mid-August, but that they do not remain in such cover for more than a few hours and do not pupate there. Further in the absence of high shade trees near tsetse cover the flies are found in the open. I am strongly of the opinion that such trees should never be removed under ordinary circumstances and that they do not represent suitable tsetse cover, as tsetse-flies are never found using them except actually close to tsetse foci. In the absence of an adjacent tsetse focus, high shade trees are not used as tsetse cover nor for breeding. Furthermore, the root system of these trees is an excellent anti-erosion system as it is low and very spreading. A feasible idea would be to plant all cleared African rivers with avenues of high shade trees."

It was with a feeling of incredulous dismay that one gazed at some of the areas clear-felled for this purpose in the three colonies of Sierra Leone, Gold Coast, and Nigeria.

In a tropical climate it is difficult to perceive, unless the areas cleared with the object of keeping down the tsetse-fly are turned into a permanent desert condition, how a regrowth of vegetation is to be prevented save at enormous cost. If reduced to a desert, erosion and interference with water supplies must in the end supervene in many localities. It may be suggested, therefore, that Mr. Stewart's recommendation might be given a wide trial in the tsetse-fly regions.

Summary of Conclusions

It has become apparent from references in the press and other more scientific articles treating of the subject, that there has arisen some confusion as to what is actually meant by erosion in different parts of the world. It has been held by some that the type of erosion being experienced in their own region has no affinity with other types elsewhere. It has been also said that too much is being made of the Sahara (other deserts might be included) and its action and relevancy to erosion and desiccation and so forth. That in effect the soil deterioration being experienced in parts of Africa can be mainly attributed to over land utilisation, whatever this may connote.

In the treatment of this important matter of erosion the effort has been made to refrain from dogmatic statements or conclusions. The sub-division of soil erosion is submitted from a purely practical view-point based on personal observation. Other divisions, or even further sub-divisions, are possible; though for ordinary purposes too minute a sub-division is, I think to be deprecated. What has been sought is a practical statement of what is understood by erosion for the man in the street.

The use of the word " drought" in connection with erosion and failing rainfall brought about by the action of man has been called in question; the substitution of the term "Intermittent Stage" is considered to portray more accurately the position arrived at. That whatever the type of erosion in force, bringing about soil degradation and depreciated water supplies and rainfall, it passes, so to speak, a half-way house at which the rainfall at first begins to show intermittency in both occurrence and fall—to, in fact, become unreliable.

When this stage begins to make its appearance under each and every type of erosion, the inhabitants of the region have termed it drought. Good rains succeed and no more is thought about the matter. But the "drought" periods gradually become more severe and succeed each other at shorter intervals until, with the far more intensive soil utilisation of modern times, as in the case of the Dust Bowls, the damage becomes quickly apparent. In spite of the fact that the particular regions have been ruined the people still talk about prolonged periods of drought—expecting, in fact, that the so-called drought will be succeeded by rainfall once again.

It is shown that, so far as a study has been carried, the intensive wasteful utilisation of the soil under which Nature's balance is upset, results in an interruption of the water supplies, springs drying up, streams running dry in the hot weather months, whilst the level of the water in the rivers drops seriously in this period—all three indicating that the water table in the soil is being lowered; and this lowering will affect the water level in wells. Following these manifestations the rainfall decreases and becomes intermittent.

It is in the early stages of this intermittency that the word "drought" may be still applicable. But since the continued mis-use of the soil will result in further depreciation in the water supplies with an increased intermittency in the rainfall it is held that the word "drought" is no longer applicable to the state of affairs which has by then arisen—in fact, that the word is dangerously misleading. Unless a cessation is put to the over-utilisation of the soils and protection afforded to the water supplies, by whatever means such protection may be accorded, there will be no recovery in water supplies or rainfall here. The periods of increasing dryness and shortness of rainfall being experienced at this stage will not be followed by a succession of wet years.

It is suggested, therefore, that when the period in erosion has been reached at which the vagaries in the rainfall begin to become marked—in other words, to become unreliable over a series of years and the amounts of rainfall received during the year become inconstant, that the position achieved should not be termed "drought," but the "Intermittent Rainfall Stage;" which in these cases of erosion under tropical and sub-tropical conditions indicates a very different and far more dangerous position. But one nevertheless, which it is believed, if taken in hand at this period is not irretrievable.

It has been stated that this period of Intermittent rainfall appears in all types of erosion and should be recognisable by all the officials having a connection with the land—Political, Agricultural, Forest, Geologist, Climatologist, and so forth.

The suggestion is put forward that when the erosion and rainfall have arrived at the Intermittent Stage, when the interruptions in rainfall are still delicately oscillating and are not established, the period has arrived at which amelioration works can no longer with safety be delayed.

For much of the type of country and the methods of livelihood of the inhabitants considered in this paper, the protective and ameliorative works may often be of a simple character—though their introduction amongst a population unused to restrictions may prove a matter of some difficulty. Closure of eroded areas to the practice of cultivation, to grazing, and to all firing will work marvels in Africa, where these three acts have been long practised unchecked. In heavily grazed areas, *i.e.*, those in which the herd or flock of animals grazing is far in excess of what the degraded pastures can produce or maintain, closure, if not delayed too late, for a few years with fire protection will be followed by a remarkable regrowth.

With the object of introducing these protective measures into a district for the first time, it may be suggested that certain type areas should be selected for protection and the reasons for the steps proposed be fully explained to the Chiefs and people. That the areas be then rigorously closed and all offences against the closure be punished when proof (not so easy to obtain) is secured.

In India, the Government of India and Secretary of State were particularly insistent in their orders on the strict observance of the fire protection system when first introduced into the country. All fire cases had to be tried in the Court of a European magistrate since it was discovered that at the outset the Native justiciary in the subordinate courts entirely failed to realise the importance of the new policy, and let off delinquents with light punishment. It was due to this unswerving support from the Central Government that the real reason for fire protection came to be understood by the community in India. It would appear that Africa will have a happier and more assured future when the people have been educated in the same way.

In Africa it is almost a direct step from the matter of fire protection to that of the farming and pasturing methods in force in certain of the Colonies. This would be a matter solely for the Agricultural Departments were it not for the system of farming and feeding stock in force; both, to a considerable extent, dependent upon the forest present on the area. It has been shown that with the increase of both population and stock the rotation of cropping under the method of shifting cultivation is becoming shorter, with the inevitable smaller yields and more rapid deterioration in both soils and water supplies—in fact, an enhanced erosion which, when stock

replace the crops, completes the degradation to desert. Since the unit of administration is the district, it is in the district that the commencement must be made, when a policy has been laid down by the higher Authority, to combat the wasteful and improvident habits of the people.

Writing for Uganda, Sir F. Stockdale says (Report on a visit to East Africa, 1937): "The application of the fruits of research to agricultural practice is one of the most difficult problems with which Departments of Agriculture are confronted."

In conclusion, mention has been made that research work in connection with erosion has been commenced in some Colonies.

It would appear that in some regions erosion has reached such a point that some of the more elementary methods to stem it should be brought into force under Government orders without awaiting the results of research work. The latter will, in due course, tell us a good deal more about water levels, depreciation in soil values, and intermittent rainfall than we know now.

But it does not require research to strengthen reports by Commissions and Committees since 1925, and earlier, of serious soil erosion in parts of Africa, which are quite sufficiently apparent with their cumulative damage and dangers: these only require to be implemented by the higher Authority.

Check the danger at the fountain head by cheap measures such as the regulation of the farming, prohibition of firing the countryside except by permission of the local Authority, and conservation and protection of all important forest areas. Only the Central Authority can introduce such measures with the recognition that they are for the good of the community as a whole. And facing the fact that they are likely at first to be met with much ignorant criticism and by opposition on the spot from the people whose old-time wasteful habits are being interfered with.—(*Extracted from Supplement to the "Journal of the Royal African Society," January* 1938, *Vol. XXXVII, No. CXLVI.*)

THE FOREST STAND OF THE BRITISH EMPIRE

COUNTRY.	Total area, Acres.	Ratio of Forest to Land Area.	Conifers Percentage.	Temperate Hardwoods Percentage.	Tropical Hardwoods Percentage.	Percentage, Public Forests.	Average Annual Cut Per Acre.
							c.ft.
United Kingdom and Ireland	3,315,000	4·3	43·0	57·0	..	3·6	13·6
British Columbia	226,186,000	15·0	95·0	5·0	..	93·0	4·2
Rest of Canada	370,560,000	18·5	72·0	18·0	..	93·0	4·2
Borneo and Sarawak	40,504,000	82·2	..	..	100	100	0·1
British India	260,139,520	22·7	1·0	1·0	98	81·1	0·1
Ceylon	13,031,040	79·9	..	..	100	92·2	1·2
Malay States	22,570,240	67·2	..	..	100	95	11·6
Honduras (British)	3,825,000	75·0	44·6	..	55·4	40·0	0·35
Newfoundland	6,400,000	23·8	93·8	6·2	..	96·0	10·5
British West Indies	2,149,000	28·2	15·0	..	85·0	80·0	9·0
British Guiana	49,780,000	86·9	..	..	100	98·8	0·1
British East Africa	3,264,000	2·1	3·0	12·0	85·0	98·0	4·1
British West Africa	164,514,000	56·0	..	..	100	100	8·0
Rhodesia	170,304,000	60·0	..	..	100	60	0·85
Union of South Africa	1,511,000	0·5	20·0	80·0	..	39·0	43·6
Rest of British Africa	19,748,000	15·7	1·0	12·0	87·0	95·0	10·0
Australia	90,291,500	5·8	4·0	11·0	85·0	79·3	2·2
New Zealand	17,073,920	25·7	68·0	32·0	..	61·4	3·9
New Guinea (British)	82,196,000	80	..	..	100	100	0·02
British Oceania	8,112,000	71·9	..	..	100	100	0·5
Total ..	*1,555,474,220*	(21 per cent. of the world's timber acreage.)					

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for April 1938 :

IMPORTS

ARTICLES	MONTH OF APRIL					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
Siam ..	..	285	258	..	32,269	31,046
Burma ..	..	14,350	12,243	..	17,73,792	17,41,977
French Indo-China	1,295	533	499	1,28,712	57,823	55,893
Java ..	..	194	107	..	26,005	7,521
Other countries ..	..	352	..	..	35,623	..
Total ..	1,295	15,714	13,107	1,28,712	19,25,512	18,36,437
Other than Teak—						
Softwoods ..	1,283	1,528	2,318	79,635	97,365	1,82,307
Matchwoods ..	1,229	1,101	744	70,471	71,442	45,734
Unspecified (value)	..	..	..	28,684	2,02,000	3,06,999
Firewood ..	39	36	62	555	539	924
Sandalwood ..	8	15	7	2,044	1,651	684
Total value ..	..	..	..	1,81,389	3,72,997	4,37,843
Total value of Wood and Timber ..	..	..	..	3,10,101	22,98,509	23,73,085
Manufactures of Wood and Timber—						
Furniture and cabinetware ..		No data			No data	
Sleepers of wood ..	..	..	59	..	..	10,431
Plywood ..	331	756	570	66,434	1,69,972	1,25,676
Other manufactures of wood (value) ..	..	..	..	1,42,756	1,77,716	1,55,884
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,09,190	3,47,688	2,91,991
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	24,023	16,683	25,459	1,49,085	1,08,566	2,50,005

EXPORTS

ARTICLES	MONTH OF APRIL					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	3,618	22	..	7,13,667	2,812	..
,, Germany ..	330	..	1	77,679	..	150
,, Iraq ..	27	44	55	8,145	8,632	18,227
,, Ceylon ..	188	..	..	30,344	..	..
,, Union of South Africa ..	393	..	..	79,872	..	..
,, Portuguese East Africa ..	224	..	..	34,902	..	..
,, United States of America ..	59	..	..	17,413	..	..
,, Other countries	228	50	124	46,958	9,705	27,597
Total ..	5,067	116	180	10,08,980	21,149	46,033
Teak keys (tons) ..	331	..	..	48,000	..	..
Hardwoods other than teak ..	46	3	..	5,258	840	..
Unspecified (value)	..	..	..	21,719	1,67,158	25,770
Firewood ..	..	115	..	..	1,027	..
Total value ..	..	..	..	74,977	1,69,025	25,770
Sandalwood—						
To United Kingdom	1	1	..	600	800	..
,, Japan ..	6	1	2	8,000	600	1,823
,, United States of America ..	50	60	75	50,000	58,040	80,000
,, Other countries	13	36	13	19,077	37,707	14,987
Total ..	70	98	90	77,677	97,147	96,810
Total value of Wood and Timber ..	..	..	..	11,61,634	2,87,321	1,68,613
Manufactures of Wood and Timber other than Futniture and Cabinetware (value)	..	..	..	8,739	16,385	17,100
Other Products of Wood and Timber		No data			No data	

INDIAN FORESTER

AUGUST, 1938.

THE TAUNGYA PLANTATIONS OF BHINGA, BAHRAICH DIVISION, U. P.

BY E. A. SMYTHIES, I.F.S.

Summary.—The forest of Bhinga, in the Bahraich division of the United Provinces, was slowly dying, as for a century or two heavy overgrazing and uncontrolled removal of small poles by surrounding villagers had prevented all reproduction. For half a century after reservation, the problem of management had proved insoluble. The current working plan of 1935-36, drawn up on the lines proposed in the preliminary report of 1932-33, has made two working circles, the larger of 21,000 acres dedicated primarily to meet village requirements for timber, firewood, fodder and thatching grass, the whole range to be intensively worked and regenerated by **taungya.**

The territorial staff, with the co-operation of the villagers, have rapidly developed the proposals, and 400 acres per annum in the two working circles are already being clear-felled and successfully regenerated with valuable species, which include a good proportion of fodder species for lopping and production of green leaf fodder.

The note describes the benefits that follow this intensive **taungya** management, and it is claimed that the long standing problem of management of the Bhinga forest has been splendidly solved. It is hoped that the lessons of the Bhinga **taungyas**, and the technique evolved, will be of wide application in creating zamindari fuel and fodder plantations in the plains districts of the Province.

One of the most striking developments of forestry in the United Provinces during the past decade has been the large-scale application of *taungya* to the regeneration of our forests, and one of the most striking examples has been in the Bhinga Range of the Bahraich division.

This Range consists of a compact pear-shaped island of 38,000 acres, about 20 miles long by 2 to 4 wide, situated on the average about 25 miles from a railway station, in a sea of highly populated and intensively cultivated land, ideal conditions for village *taungya*. The bulk, *i.e.* 30,000 acres of the area, is flat and culturable, with stiff clay-loam soil, passing down to a sandy loam or loamy sand at some feet in depth. Part of the area is mild ravine, and there are

several thousand acres of *rehar* which is unfit for cultivation or tree growth.

2. For more than half a century after reservation, this forest provided an insuperable problem to forest management. It is necessary to get a clear understanding of the problem in order to appreciate how the application of *taungya* has solved it.

All villages within a distance of three miles from the outer boundaries—a total of 86—have first claim on forest management. Their requirements are:—

(*i*) unlimited grazing on payment;

(*ii*) timber in large quantities for their village houses, 3″ to 8″ diameter (large timber is of no use to them). The maximum amount is fixed at 195,000 c.ft. per annum; a meaningless figure, as the actual requirement to meet the villagers' needs is 15,000 to 20,000 c.ft.;

(*iii*) firewood. Four cartloads (or equivalent in headloads) per house; say, 30,000 carts per annum;

(*iv*) thatching grass. Two cartloads per house, or 15,000 carts per annum;

(*v*) thorns for fields—no limit.

3. Given a century or two of uncontrolled demand of this nature, any forest officer will accurately picture the type of derelict and dying forest which we took over in 1879. There were large, scattered trees of unknown age (but nearly all hollow and over-mature) of sal, *haldu* (*Adina cordifolia*), *tendu* (*Diospyros tomentosa*), *mowha* (*Bassia latifolia*), figs, *jaman* (*Eugenia jambolana*), standing over thickets of inedible thorny shrubs, chiefly *karaunda* (*Carissa opaca*), or, in areas on the outer edges where grazing was worst, over bare beaten ground. Any odd sapling that somehow escaped the intense and perpetual grazing, was greedily felled to meet the demand for 3″ to 8″ timber. The combination made recruitment and regeneration utterly impossible.

A good idea of the extremely abnormal forest which has resulted from the lack of recruitment for a century or more is given by the sal enumeration figures of 1934 for the outer zone of forest (*i.e.* the

Fig. 1.—Overgrazed and dying forest before **taungya** operations start. Large dying trees standing on bare ground or over inedible thorn scrub. Hungry cattle feeding on green leaf fodder (lopped branches), the ground being bare of grass.

Fig. 2.—Taungya operations start. The trees have been sold and exported, and the cultivators have started breaking up the soil with **phowras** (hoes) and digging out stumps, in preparation for the first **kharif.**

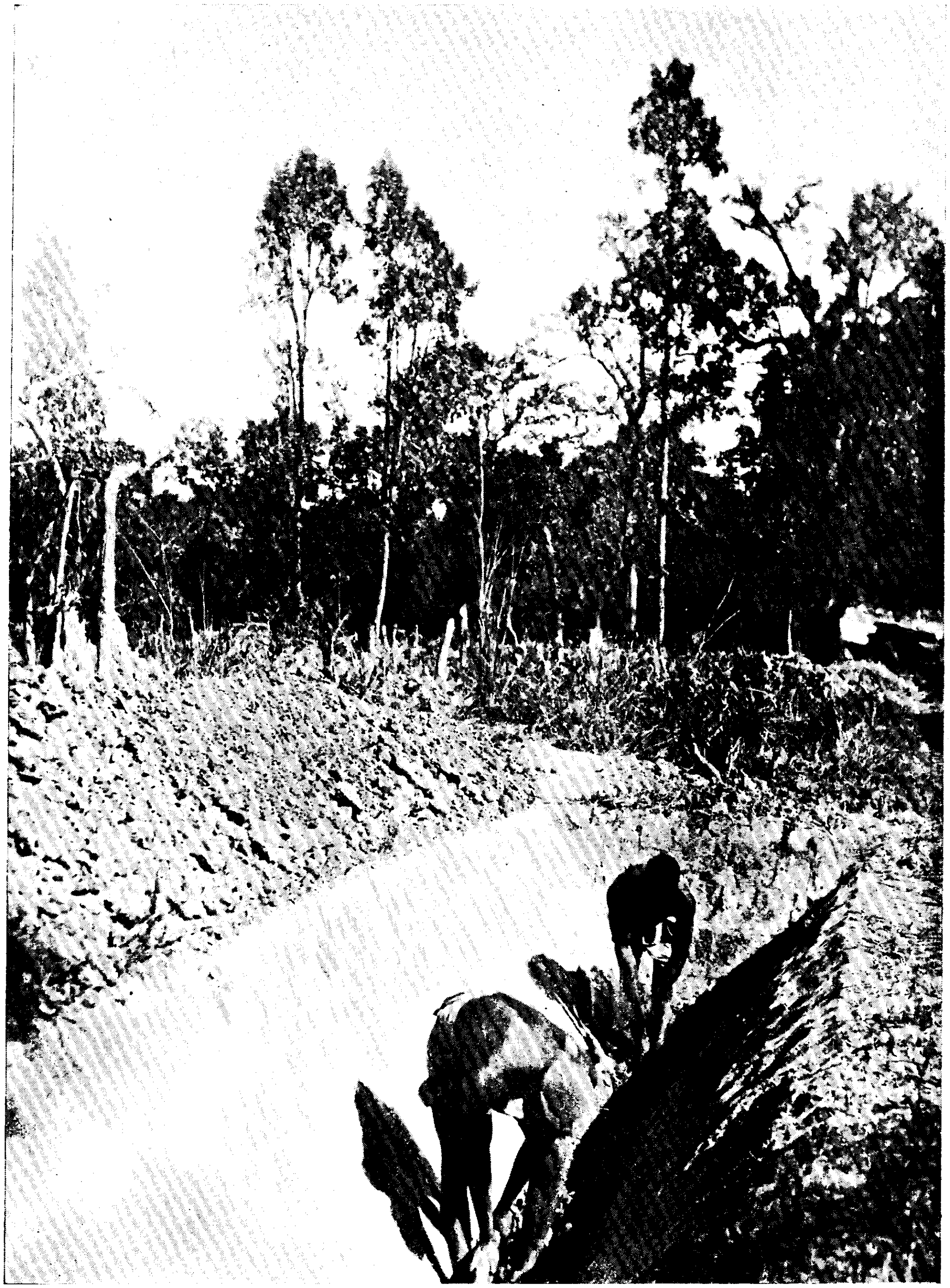


Fig. 3.—Cultivators digging a pig- proof ditch around the **taungya** area.

present "concessionist" working circle), which are as follows (for about 16,000 acres): —

Diameter class.	*Numbers.*	*Remarks.*
12″ to 16″	2,500	Mostly old trees on bad soil.
16″ „ 20″	4,600	
20″ „ 24″	6,500	
Over 24″	24,700	All over-mature.

A forest where the over-mature class is almost double the next three-diameter classes put together is indeed unique! This may be compared with the numbers of sal trees per 100 acres of a normal II quality forest on 100-year rotation (*c.f.* Forest Pocket Book, page 204):

Diameter class.	*Numbers.*
12″ to 16″	2,540
16″ „ 20″	1,010
20″ „ 24″	200
Over 24″	30

An interesting picture of the conditions in Bhinga 30 years after reservation is given in a letter dated August 4th, 1909, of the United Provinces Government dealing with the 1909 Working Plan, from which the following extract is taken:

"In paragraph 173 of the Working Plan, it is stated that the supply of fodder in the Bhinga working circle is at present quite inadequate to support the large herds of cattle which are allowed to graze in the forests, that the area is in consequence rapidly deteriorating, and that no improvement can be expected so long as the present concession rules remain in force. To remedy this state of affairs it is suggested that cattle be completely excluded from these forests, and that concession-holders be allowed to remove cut fodder only. The Lieutenant-Governor, after consulting the local civil officers on the subject, agrees that in the Bhinga working circle the proper preservation of the forest is incompatible with the maintenance of grazing concessions on their present scale. The soil in this circle is said to be such that the trampling of cattle reduces the surface to a hard cake through which neither grass nor trees can grow. However unpopular a restriction of the concession be with the concession-holders, they will, the revenue officers think, if the existing

concessions are not restricted, find themselves in 15 years the owners of worthless rights to grass and timber no longer existent. The suggestion, however, that grazing should be discontinued and that permission should only be given to remove cut fodder is regarded by those officers as impracticable because the villages are situated at some distance outside the forest, and one man working all day would be able to cut fodder sufficient for not more than four head of cattle. The alternative suggestion made by the revenue officers is to reduce the number of cattle admitted to grazing."

This reduction of grazing incidence was, in fact, never carried out, and it reached a peak of 24,000 head in 1924.

4. Fifty years after reservation, it must be confessed that the bulk of the open forest showed very little change. The old trees were half a century older, more hollow, rather more scattered, and the ground of the open areas (24,000 acres) barer, or the vegetation more inedible. The head of cattle had increased to 24,000.

There was, however, a central core of about 14,000 acres which had been closed (since 1895) to grazing and to unregulated felling of younger poles, where small groups of sal and *asna* (*Terminalia tomentosa*) saplings and unestablished sal regeneration were beginning to show up, indicating that nature did not intend this to be a derelict forest. But the process of recovery was obviously very slow.

When I first visited this forest (as Silviculturist) in 1921-22, the above gives a general idea of the condition of these forests. I suggested that the possibility of *taungya* plantations deserved consideration and might be employed. In 1924 the Divisional Forest Officer (Mr. Davis) started departmental *taungya* on an experimental scale, with teak, *sissu* (*Dalbergia sissoo*) and *khair* (*Acacia catechu*). Although subsequently left unthinned for 12 years, these early experiments have now developed into well-stocked pole crops 7" to 8" in diameter, and after a heavy thinning are developing very well. (See Figs. Nos. 7 and 8.)

The thinnings in 1937 sold for Rs. 15 per acre, and also much material was made available for the villagers.

5. Ten years later, when I next visited these forests (as Conservator, Working Plan Circle) and wrote a preliminary working plan

Fig. 4.—Wheat and gram crop in the third **rabi** with line of tree seedlings 6 months old. Note the fine wheat crop, breast high.

Fig. 5.—**Taungya** cultivation given up. Tree plants 3½ years old (**jaman, sal, asna**).

Fig. 6 (a).—Tree crop of **asna** and **khair** 6½ years old, standing over fodder and thatching grass.

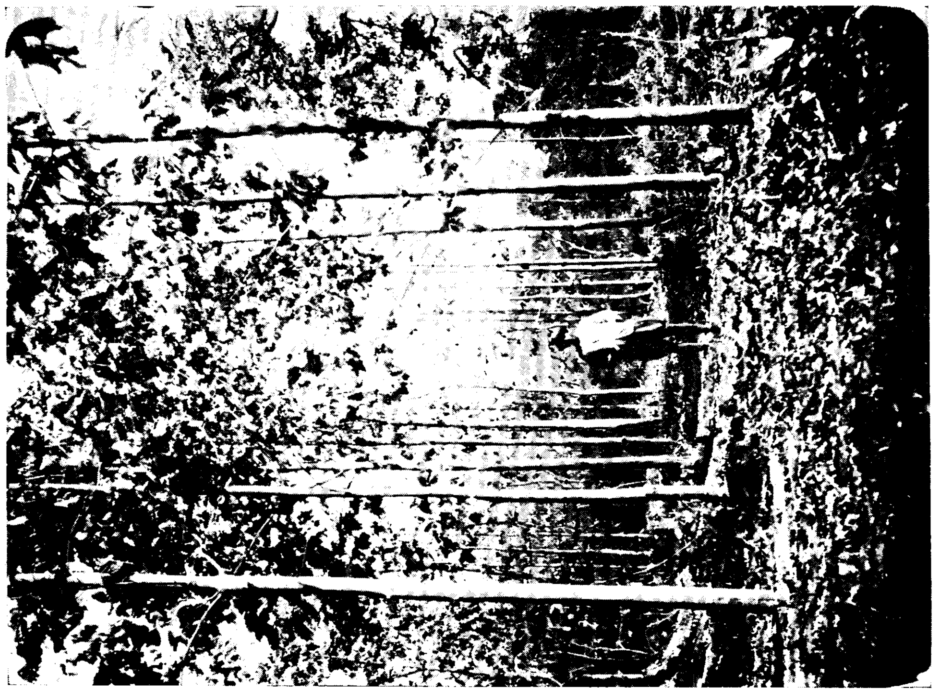


Fig. 6 (b).—Pure teak crop 13½ years old.

report, the 24,000 acres of open forests had deteriorated further, the 14,000 acres of closed forests showed further considerable improvement, amounting in parts almost to reinvasion by sal, and the total area of *taungya* plantations had increased to over 300 acres. At the same time, the grazing incidence had dropped to 11,000 head of cattle, but the difficulties of the villagers in getting 3″ to 8″ timber still remained an acute problem.

In my preliminary report, I proposed a permanent distribution of the forest area into two working circles:—

(*i*) An inner working circle of 16,500 acres (14,000 acres fit for *taungya*) primarily to grow sal and other valuable timber species for revenue, but small poles would be available for villagers.

(*ii*) An outer working circle of 21,500 acres (16,000 acres fit for *taungya*) primarily to meet the requirements of the villagers, for grazing, small timber, green leaf fodder, thatching grass, etc.

Both working circles to be regenerated by *taungya* as far as possible, and every effort should be made to work up to 200 acres per annum of *village taungya* in *each* working circle, *i.e.* a total of 400 acres of *taungya* per annum in this Range! It was a bold scheme to suggest *taungya* work on this large scale in one Range, and it was a revolutionary proposal to suggest intensive management of an area of over 21,000 acres of potentially valuable reserved forest *primarily for the use of villagers.* The proposals were approved and sanctioned in 1933, and the working plan, prepared by Mr. Hopkins (Working Plan Officer), under the control of Mr. Howard (Conservator, Working Plan Circle), made proposals for management on these lines for 15 years, 1936-37 to 1950-51.

6. When I made these suggestions five years ago, they were an ideal to aim at, and I confess I never expected to see this ideal attained. Even in 1935, the full allotment of 400 acres per annum was a pious hope rather than a concrete reality. It is, therefore, enormously to the credit of the present Divisional Forest Officer (Mr. Haq) and of the Range Officer (Forest Ranger Nazir Ahmed) to state that *taungya* cultivation has increased so rapidly during the past three years that not only are the full 400 acres per annum now being done, but it is considered possible to increase by another 100

acres per annum in the concessionist working circle to a total of 500 acres per annum for the Range as a whole.

Some details of this *taungya* development will be of interest. At the present time, there are 12 *taungya* centres in the whole Range with nearly 800 tenants and sub-tenants. 400 acres are now clear-felled annually and in all, since 1927-28, nearly 2,000 acres have already been planted up, or placed under cultivation preparatory to sowing tree species.

7. To start with, in order to attract cultivators, two years of cultivation were given, with tree species to be sown on prepared soil in the third monsoon. A clear-felling coupe is sold by auction in March-April, and the timber contractor or purchaser has to clear it, and dig up the larger stumps by the following 1st February, when the land, with numerous small stumps and scrub growth is made over to the cultivator. He cuts down the scrubs, digs up roots, and hoes up the ground by June, in time for the first *kharif* sowing. The time table has been roughly as follows:—

March 1934	...	Coupe sold by auction;
„ 1935	...	Land made over to cultivator;
June-July 1935	...	First *kharif* sown, followed by first *rabi;*
July 1936	...	Second *kharif* sown, followed by second *rabi;*
„ 1937	...	Third *kharif* sown and tree seeds in lines.

Owing to the keen demand for land, it has now been found possible to give out land on condition that the tree seeds are sown in the second *kharif, i.e.* a gain of one year.

After the sowing of the tree species, two or three more *kharif* and *rabi* crops are harvested where the slow-growing species (sal, *jaman, mohwa*) are developing, and one or two more *kharif* and *rabi* crops where the quick-growing species are developing. The cultivation and soil working is magnificent, and all weeds are thoroughly eradicated. In the timber working circle, the principal species are sal, *jaman, mohwa,* and to a limited extent, *sissu* and teak, and the lines are 12′ to 15′ apart. In the concessionist working circle, we are introducing fodder species mainly for lopping, principally *Terminalias, Albizzia, Bauhinia, nim* (*Melia indica*), mulberry, while species mainly for timber are *sissu,* sal, *Bombax,* mango, etc., with *jaman* as an understorey everywhere for fruit and small timber,

Fig. 7.—Sissu, khair (and one teak), 12½ years old.

Fig. 8.—**Sissu** and **khair** crop 13½ years old. Teak of same age in background. The **sissu** crop is 2 feet girth and 35 feet high.

in lines 25′ to 30′ apart, to enable fodder and thatching grasses to develop for a period of years between the lines. A timber line will alternate with a fodder line, and the *jaman* will probably be coppiced on a short rotation under the light demanders to provide abundance of small timber for the villagers.

8. The working plan prescriptions, as worked out by the territorial staff, provides a scheme of immense possibilities for the amelioration and betterment of the population of the surrounding 86 villages. Already, the supply of small timber, available from thinnings of the young plantations, has increased enormously, and in a very short time at the present rate of development of these *taungya* plantations, it is very clear that there will be more small timber available for villagers than they can possibly use. And this in a forest where a few years ago there was very little except enormous hollow and deteriorating old trees standing over bare ground or thorny *karaunda* shrubs!

As regards *green leaf fodder,* the plantations are still too young to permit of lopping (the idea of lopping species was made for the first time in my preliminary report of 1933), but the production of fodder from the 1,200 acres or more of *kharif* and *rabi* crops is about 40,000 maunds per annum as detailed later.

As regards firewood, the clear-felling of 400 acres of forest per annum, plus thinnings and cleanings, have made available a supply of fuel far in excess of villagers' requirements. So much so that considerable quantities of fuel were being wasted until the Divisional Forest Officer, Mr. Haq, had the happy idea of starting brick-kilns on some of the *rehar* land unfit for any other use. Four new kilns have been started, and about 150,000 maunds of fuel per annum will now be absorbed in burning bricks, and thus an excellent local market has been developed for the surplus fuel, which increases employment all round in the locality.

As regards *fodder and thatching grasses,* these appear in the *taungya* plantations as soon as cultivation is stopped, and continue for a number of years under the tree crops, unimpaired by the thorny shrubs which the *taungya* operations have eradicated.

Thus *taungya* operations, by rapidly removing dying trees and valueless species, and introducing valuable species instead, are

rapidly improving the supplies of small timber, fodder, fuel and thatching grass for villagers, and simultaneously establishing valuable commercial timbers for revenue production and development of provincial industries. The latter will take some decades to mature, but the former, *i.e.* supplies to villagers, are already a rapidly swelling snowball. Apart from increasing supplies to concessionist villagers, the more intensive exploitation, rendered possible by the *taungya* operations, has greatly increased the revenue and export, *vide* figures given below, which compare the figures of 1932-33 (*i.e.* the year in which I suggested the present working plan prescriptions) with those of 1936-37, the latest available:—

Nature of produce.	Agency of removal.	1932-33. c.ft.	1936-37. c.ft.
1. Timber (all sorts)	Purchasers and contractors	126,000	2,52,000
1 (*a*) Sal timber only	,,	95,000	1,90,000
2. Fuel	,,	95,000	1,58,000
3. Thatching grass	,,	-	17,8000 mds.
3 (*a*) ,, ,,	Concessionist	3,700	14,000 ,,
Total revenue of the Bhinga Range (from timber)		Rs. 25,000	Rs. 66,000

These figures will also indicate the enormous increase in employment and wages that the more intensive management of the forest now provides to the surrounding population. For example, 3,000 sawyers are now employed, while the labour on felling and carting has about trebled. Apart from the 8,000 households who benefit by free concessions, a further 15,000 or more find employment and wages. The prosperity of the town of Bhinga depends very largely on the forest.

9. The indirect benefits of these *taungya* operations to the villagers must also be mentioned. All the *taungya* cultivators come from the adjoining villages, and while keeping their cultivation in the zamindari, undertake additional cultivation in our forest. At present about 800 different cultivators are growing their crops on about 1,200 acres of land; in the very near future these figures will probably increase to 1,000 cultivators and 1,600 acres. Here, as everywhere, in our forest *taungyas*, the fertility of our forest soil has a

marked effect on the crops harvested. Thus the *taungya* wheat crops yield on the average a 100 per cent. increase over the adjoining zamindari wheat crops! Some interesting figures of approximate cash value of crops per cultivator have been supplied to me by the Divisional Forest Officer, of which I give a summary below (for 1937-38 *kharif* and *rabi*). 800 tenants and sub-tenants cultivated 1,226 acres of *kharif* (maize), 679 acres wheat, 547 acres mustard. The total approximate yield and value of the crops were:—

					Rs.	
Maize	.. 25,000	maunds	@ 2/-	per maund	.. 50,000	(*kharif*)
Wheat	.. 12,500	„	„ 4/-	„ „	.. 50,000	(*rabi*)
Mustard	.. 9,000	„	„ 5/-	„ „	.. 45,000	
Kharif fodder	.. 32,000	„	„ -/1/-	„ „	.. 2,000	
Rabi bhusa	.. 10,000	„	„ -/5/-	„ „	3,000	
Total cash value of crops				..	1,50,000	

Divided amongst 800 tenants = Rs 188 per tenant.
„ over 1,226 acres — „ 123 per acre.

10. It should be noted that, following our universal practice in *taungya* operations, the cultivators get the land and crops free of rent, they receive free medicines, and of course they help themselves to forest produce and grazing freely for all their needs. They work hard, and are prosperous and very happy. When not engaged in tending their crops, they can supplement their income by earning wages on departmental works or with the timber contractors, and the great increase in forest activities since *taungya* operations started has considerably increased the demand for labour, carting, etc., and hence the circulation of money and employment amongst the poorest classes in the locality.

In course of time, the introduction of *jaman*, mango, and *mohwa* will increase the food supply, while *nim* gives a useful oilseed in abundance. Again, mulberry, besides giving an excellent leaf fodder for the cattle, produces shoots useful for basket-making. In these and in other ways, the *taungya* operations will have a profound influence on the well-being and economic conditions of the adjoining rural population. The most interesting feature of the whole scheme is, I think, that it is the cultivators themselves who are making these improvements at practically no cost to Government, under the control and expert advice of the forest staff, and benefiting themselves

and their successors on a scale that has its only parallel in these provinces in the well-known Saharanpur *taungyas*. But the scheme was only made possible by the broad-minded acceptance by Government of our proposals to dedicate and manage more than 20,000 acres of forest land primarily for the benefit of the surrounding villages.

11. The illustrations to this note give a better view than any lengthy written description of the conversion of a dying forest into vigorous and a valuable *taungya* plantations, and the typical development of the latter year by year over a period of 16 years from the first commencement of *taungya* operations. In one particular the Bhinga *taungyas* differ from the corresponding well-known Saharanpur *taungyas*. In U. P. Forest Bulletin No. 10, which describes the Saharanpur *taungyas* in detail, stress was laid on the excellent work connected with village uplift (schools, sanitation, *panchayats,* etc.). In Bhinga, however, there are no permanent villages as in Saharanpur; the cultivators still keep their homes in the zamindari villages, and, except at two centres, do not reside permanently with their families in the *taungyas*. Hence the scope for schools, *panchayats,* and so on has not arisen. Should the need arise in future, however, this matter will receive the same sympathetic treatment. The chief features that impress the visitor to the *taungya* centres are the high standard of intensive cultivation, the absence of wild animal damage, and the obvious friendliness and happiness of the cultivators. Free of the surrounding forest and all its produces, free of rent and revenue collection, free of quarrels and crime, debt, the bania, and the usual village troubles, they live a happy, healthy life with bumper crops to reward their efforts.

12. From the provincial point of view, the importance of the Bhinga *taungyas* is, in my opinion, the possibility of applying the technique here developed for creating village fuel and fodder plantations in the plains districts. The present Government recently appointed an I. F. S. officer on special duty to explore, in close co-operation with the Rural Development Department, the possibilties of creating village *taungya* plantations, and as Chairman of the U. P. Fodder and Grazing Committee, I have had a good deal to do with the development of the idea of village plantations in the districts far removed from forests. The requirements of the Bhinga villages

are the same as those of any other plains villages, the soil conditions and methods of agriculture are also the same, and so are the humble cultivators. It is, therefore, only reasonable to suppose that the technical layout, which is succeeding so well in Bhinga, will succeed equally well elsewhere. When one realises that the cattle population of the province requires something like 40 lakhs of maunds of fodder *per day*, and that millions of tons of cowdung are burnt as fuel annually, for want of any alternative instead of being utilised as manure, the immensity of the possibilities will be appreciated. Add to this that the area classed as "culturable waste" excluding fallow in the plains districts of the province exceeds 10 million acres (*i.e.* about three times the total area of reserved forest, excluding the inaccessible Himalayas), some of which at least must be suitable for *taungya* plantations, and the importance of the technical work on fuel and fodder *taungya* plantation at the two main forest centres, Bhinga and Saharanpur, will be appreciated. On the results obtained to date we can claim to have evolved a satisfactory and cheap method of creating such plantations on suitable culturable land by means of *taungya,* which can be carried out on any scale, whether small *baghs* or big plantations, by the ordinary methods of cultivation as practised in the plains districts by the ordinary cultivators. It is at present impossible to foresee what developments will result in future, but I believe that if sufficient suitable land is made available on terms attractive alike to the landlords and the tenants, and no insuperable practical difficulties arise, we have evolved an idea that may profoundly affect and improve the economic conditions of the rural population of the province. The U. P. Government have spent crores of rupees of capital on major irrigation and hydro-electric works, but *taungya* plantations require no capital, only expert technical advice and possibly supplies of tree seeds not available in the plains.

Recently the daily press reported a speech by an Hon'ble Minister in Madras as follows: —

Madras, February 11.

"That the Government proposed to institute a 'Tree Planting Week' was revealed by Mr. Muniswami Pillai, Agriculture Minister, speaking at Singayagonda, Nellore district.

"The Minister said that the famine-stricken condition of the people was due to the denudation of the forests. Unlike the United

Provinces, which had a 40 per cent. forest area, Madras possessed only 12 per cent. It was necessary to raise the percentage to 20."

The Hon'ble Minister in Madras made one mistake, since (excluding Kumaun) the forest area in the United Provinces is 4 per cent. and not 40. If it is necessary for the Madras Government to urge an increase from 12 to 20 per cent., is it not necessary for the United Provinces to urge some increase over 4 per cent.? All official and non-official members on the Fodder and Grazing Committee, who have considered the matter, are unanimous on the point that there is need and scope for enormous development and benefit to the village population.

This, however, is rather a digression from the main subject of this note, namely the Bhinga *taungyas*.

In conclusion I must record unstinted praise for the local forest staff, for the way in which they have developed and worked the scheme, which, although I suggested it myself five years ago, I never expected to see developed so smoothly and efficiently in such a short period. The policy, accepted by Government since 1933, of setting apart a large area of forest land primarily to improve the conditions and meet the requirements of 86 villages, has been fully justified by results, and the problem of the Bhinga forest that puzzled forest administration for more than half a century has been satisfactorily solved.

WOOD FOR SPORTS GOODS

By V. D. Limaye, B.E. (Mech.)
Officer-in-Charge, Timber Testing Section, Forest Research Institute, Dehra Dun.

Abstract.—Wood is, by far, the most important material employed in the manufacture of a variety of articles used for sport and amusement. That Indian manufacturers are taking a keen interest in the production of these goods is evident from the number of enquiries received by the Forest Research Institute for advice regarding suitable Indian woods for their manufacture. Sports goods can be divided into several groups, each requiring timbers with different qualities. It is the intention in this short note to give a general idea of the Indian timbers that are being used at present, or that could be utilised, in this field.

Tennis and Badminton Rackets, Hockey Sticks, and Cricket Bats etc.—For such articles as tennis and badminton rackets and hockey sticks, the wood must combine, lightness with very great toughness and straightness of grain, and it must also be able to withstand considerable over straining

without a short fracture. The Indian wood found most suitable for this purpose is mulberry (*Morus* spp.) which is at present only available from the irrigated plantations of the Punjab. The success of Sialkot as a centre of Indian sports goods manufacture is due very largely to the availability of mulberry in the province. It is a formidable competitor to European ash in this respect, and very large quantities of mulberry hockey sticks and tennis rackets are being exported to Europe and other countries every year. Plantations of mulberry in suitable areas should prove profitable. The demand for mulberry in India already exceeds the supply, and good prices are obtained for the wood. *Celtis australis, Robinia pseudacacia* and *Prunus padus* from the North-West Frontier Province are also very suitable woods, and are, as a matter of fact, already being used for sports goods in quite a large way.

A fairly recent fashion in tennis rackets is the use of a laminated rim construction instead of a solid rim. Apart from effecting economy in the consumption of mulberry, this construction allows a more scientific design of the racket. The outer plies, which are subjected to the cutting action of strings, can be made of a strong, hard wood, while the inner plies can be of a softer, cheaper and lighter material. Ornamentation is also secured by using plies of different colours. Where more than three plies are used, the central ply could be made of a coloured wood like rosewood, which would enhance the beauty of the racket and would give it at the same time greater strength. Various combinations of mulberry, *bakain* (*Melia azedarach*), neem (*Melia indica*), *bahan* (*Populus euphratica*), *chinar* (*Platanus orientalis*), ash (*Fraximus* spp.), etc., are employed by different firms in Sialkot for this purpose.

Bamboo has been successfully used by a firm in Siam for the manufacture of tennis rackets with laminated rims. The outside and inside laminæ are of bamboo while the central laminæ are made of a softer wood, namely *kuda* (*Holarrhena antidysenterica*). The throat is made of bamboo rhizomes, and the grip of *Trewia nudiflora*. Bamboo, *Holarrhena antidysenterica* and *Trewia nudiflora* are to be found in several provinces in India. Only some enterprising manufacturer is required to overcome the initial prejudice and introduce the new article. As a matter of fact such rackets are extremely strong and appear to have more "give" than a plywood racket.

For the blades of hockey sticks, mulberry, elm and *chinar* are used, and the handles are made of cane.

For cricket bat blades, the cricket bat willow is universally used both in India and abroad. Indian cricket bat willow comes only from Kashmir. The tree is a hybrid identified as *Salix alba* × *fragilis*. The wood required for cricket bats must be light, elastic, straight-grained and even-textured. It should not shatter and chip off when the ball hits it, and it should be comparatively soft and compressible. Elm is sometimes used, but no wood as good as willow has yet been discovered. On the other hand, no other species seem to have been seriously tried by manufacturers. The fact that Kashmir is at present contemplating an export duty on willow and the starting of sports factories inside the State should give an impetus to the trial of other species and the growing of cricket bat willow in other suitable localities. As cricket bat willow has not yet been seriously tested in Dehra Dun, it is rather difficult to suggest substitutes, but *Michelia excelsa* and *Michelia champaca* from Bengal and Assam, *Polyalthia fragrans* from Madras, *Holarrhena antidysenterica (khuda)* and *Hymenodictyon excelsum* found in many provinces are worth a trial. It is true these woods have never been used for this purpose and they may not be found suitable. But it is also true that actual practical tests only can reveal their fitness or otherwise for the purpose in view. Good cricket stumps can be made of sissoo (*Dalbergia sissoo*). Stumps of this wood have been used with satisfaction for a number of years at Dehra Dun.

Another important branch of sporting goods industry is gymnasium equipment. The demand in this field should be great in future due to the increased attention that is now being paid to the health of school boys.

Equipment such as Indian clubs, dumb-bells, horses, parallel and horizontal bars, trapeze bars, malkhamb and similar appliances require straight-grained, strong, tough woods. *Acacia arabica* (babul, *Pterocarpus marsupium* (bijasal) and *Dalbergia sissoo* (sissoo) are well suited for Indian clubs, dumb-bells and malkhamb. They are durable, heavy, and take a smooth hard finish. For trapeze and parallel bar construction *Grewia tiliæfolia* (*dhamin*) provides a strong, tough timber. *Anogeissus latifolia* (axle-wood) would also

be very suitable if seasoned slowly, and if careful selection is made in order to avoid hair cracks. The vertical posts of parallel bars can be made of any strong timber, such as sal, sissoo, babul, bijasal, etc.

Teak provides one of the best woods for making spring boards and is giving satisfactory service in swimming baths in many places. It is very strong and elastic, and is especially suitable in places subjected to alternate drying and wetting as it does not easily decay. It can also be obtained in almost any width and length desirable.

Cane and bamboo are very suitable for polo sticks. Bamboo root is the favourite material for polo stick heads and balls. Babul could be used for the heads. It can also be used for golf club heads in place of imported persimmon. *Grewia* and *Lagerstrœmia* species have been used with success as golf shafts.

Solid bamboo (*Dendrocalamus strictus*) is the best material for *lathis*, jumping poles, javelins, and lance shafts. It is cheap, light, very strong, tough and hard. Solid bamboo is also an excellent material for making both built up and one-piece fishing rods, and is used extensively for this purpose in India. It used to be used by the large fishing-rod makers in Europe, but the trade dwindled owing to Indian suppliers failing to keep up the standard of supply. The trade is now mainly in the hands of the Japanese.

UNDERGROWTH AND THE BIOLOGICAL CONTROL OF TEAK DEFOLIATORS

By C. F. C. Beeson, Forest Entomologist.

Abstract.—The value of undergrowth in the biological control of defoliators in teak plantations has been investigated and species of plants are listed which are (a) desirable because they are the food-plants of defoliators that are alternative hosts of parasites of **machaeralis** and **puera,** or (b) undesirable because they are alternative food-plants of **machaeralis** or **puera** or of other pests of teak. A statement of the distribution of identified parasites of teak defoliators is given, and experiments in the introduction and colonisation of parasites between Burma, North India and Madras are described.

In the *Indian Forester* for October 1934, pp. 672—83, the principles of the biological control of defoliators in teak plantations were discussed and the value of a mixed flora in the undergrowth and underwood obtainable by jungle regrowth and reseeding was defined in general terms. Protection against defoliators is not necessarily ensured by growing teak in mixture, that is to say, in a crop which answers the silvicultural definition of mixture. To be of use in biological control a plant species associated with teak must be a contributory factor in the maintenance of the natural enemies of the

teak defoliators. It must support insects which are either (*a*) alternative hosts of parasites of teak defoliators, or (*b*) alternative food for polyphagus predators. Further, it must not be an alternative food-plant of a pest feeding on teak.

Recent work at Nilambur, Madras, and in teak plantations elsewhere enables us to classify many of the commoner plants, shrubs and trees associated with teak in two groups, which may be termed "desirable" and "undesirable," from the aspect of defoliator control. This note puts on record preliminary lists of plants which are desirable as sources of parasites of *Hapalia machæralis* and *Hyblæa puera*; and also of plants which are undesirable because they are alternative food-plants of these two caterpillars. A preliminary list of the plants which are desirable as sources of predators is not yet available as the investigation is still in progress.

Plant Species in the Biological Control of Teak Defoliators.

The following species of plants are desirable in teak plantations because they are the food-plants of defoliators that are alternative hosts of parasites of *machæralis* and *puera*.

Plant.	*Defoliator.*	*Parasite.*	*Machæralis or Puera.*
Achyranthes aspera	Psara stultalis	Elasmus brevicornis	M. P.
Anthocephalus cadamba	Margaronia hilaris	Cedria paradoxa	M.
Bamboo	Pyrausta coclesalis	Cedria paradoxa	M.
Bauhinia racemosa	Salebria strigivenata	Phanerotoma hendecasisella	M.
Bœhmeria malabarica	Pyralidæ unnamed	Cedria paradoxa	M.
Bœhmeria platyphylla	Sylepta balteata	Cedria paradoxa	M.
Bœrhaavia diffusa	Psara stultalis	Elasmus brevicornis	M. P.
Borassus flabellifer	Nephantis serinopa	Brachymeria nephantidis Trichospilus pupivora	M. P.
Casearia graveolens Casearia tomentosa	Botyodes asialis	Cedria paradoxa Trophocampa indubia	M. M.
Cassia fistula	Nephopteryx rhodobasalis Pilocrocis milvinalis	Phanerotoma hendecasisella Cedria paradoxa	M. M.
Cedrela toona	Hypsipyla robusta	Brachymeria euplœæ Phanerotoma hendecasisella Trichogramma minutum	M. P. M. M.
Celastrus paniculata	Hypargyria metalliferella	Phanerotoma hendecasisella	M.
Dalbergia sissoo	Dichomeris eridantis	Phanerotoma hendecasisella	M.
Diospyros montana	Hypocala moorei Prodenia litura	Dioctes argenteopilosa	M.
Diospyros tupru	Botyodes asialis	Cedria paradoxa	M.
Ehretia lævis	Azinis hilarella	Cadurcia zetterstedti	M.
Elæodendron glaucum	Cacœcia epicyrta	Cedria paradoxa	M.
Eugenia operculata	Agrotera basinotata	Cedria paradoxa Goniozus montanus	M. P.
Flemingia chappar Flemingia paniculata	Lamprosema diemenalis	Cedria paradoxa Trophocampa indubia	M. M.
Grewia disperma Grewia lævigata Grewia sp.	Pyralidæ unnamed	Cedria paradoxa	M.
Grewia sp.	Lygropia sp.	Cedria paradoxa	M.

Plant.	*Defoliator.*	*Parasite.*	*Machæralis or Puera.*
Helicteres isora	Lygropia obrinusalis	Cedria paradoxa	M.
		Phanerotoma hendecasisella	M.
	Lygropia quaternalis	Cedria paradoxa	M.
		Phanerotoma hendecasisella	M.
		Brachymeria euplœæ	M. P.
		Brachymeria obscurata	P.
		Goniozus montanus	P.
Holarrhena antidysenterica	Margaronia laticostalis	Sturmia inconspicuella	M. P.
Homalium tomentosum	Pyralidæ unnamed	Cedria paradoxa	M.
Jasminum pubescens	Hendecasis duplifascialis	Phanerotoma hendecasisella	M.
Lagerstrœmia flos-reginæ Lagerstrœmia lanceolata Lagerstrœmia parviflora	Agrotera basinotata	Cedria paradoxa	M.
		Goniozus montanus	P.
Leea sp.	Sylepta lunalis and sp.	Cedria paradoxa	M.
		Goniozus montanus	P.
Morus alba Morus indica	Margaronia pyloalis	Brachymeria euplœæ	M. P.
		Phanerotoma hendecasisella	M.
		Cedria paradoxa	M.
	Margaronia sp.	Cedria paradoxa	M.
Ougeinia dalbergioides	Lamprosoma diemenalis	Cedria paradoxa	M.
	Maruca testulalis	Brachymeria obscurata	P.
		Phanerotoma hendecasisella	M.
Pavetta indica	Agrotera basinotata	Cedria paradoxa	M.
		Goniozus montanus	P.
Peristrophe bicalyculata	Pyralidæ unnamed	Cedria paradoxa	M.
Pterospermum rubiginosum (or reticulatum)	Pyralidæ unnamed	Cedria paradoxa	M.
Ricinus communis	Achæa janata	Ptychomyia remota	M. P.
	Dasychira mendosa	Tachina fallax	P.
Solanum indicum Solanum torvum	Prodenia litura	Dioctes argenteopilosa	M.
Solanum sp.	Acharana mutualis	Sturmia parachrysops	M.
Swietenia macrophylla	Hypsipyla robusta	Brachymeria euplœæ	M. P.
		Phanerotoma hendecasisella	M.
		Trichogramma minutum	P.
	Lamida sp.	Cedria paradoxa	M.
Terminalia belerica	Pyralidæ unnamed	Cedria paradoxa	M.
Terminalia paniculata	Dasychira mendosa	Tachina fallax	P.
Xylia xylocarpa	Maruca testulalis	Brachymeria obscurata	P.
		Cedria paradoxa	M.
		Phanerotoma hendecasisella	M.

18 of the plants are factors in the control of *Hyblæa puera* and

46 in the control of *Hapalia machæralis*.

Crops in *taungya* or neighbouring agricultural land :—

Cotton	Parias insulana	Phanerotoma hendecasisella	M.
	Erodenia litura	Dioctes argenteopilosa	M.
	Sylepta derogata	Elasmus brevicornis	M. P.
		Ptychomyia remota	M. P.
Rice	Spodoptera mauritia	Tachina fallax	P.
		Trichospilus pupivora	P.
Sugarcane	Emmalocera depressella	Trichogramma minutum	P.
Tobacco	Prodenia litura	Dioctes argenteopilosa	M.

B

The potentially most useful* plants are those that support defoliators which are alternative hosts of parasites common to both *machæralis* and *puera, e.g., Achyranthes aspera, Bœrhaavia* sp., *Helicteres isora, Holarrhena antidysenterica, Morus alba, Ricinus communis.*

In the second class of usefulness may be grouped those plants that support defoliators which are alternative hosts of the polyphagous parasites commonly attacking *machæralis* or *puera, e.g.,* the five plants supporting *Phanerotoma hendecasisella* for conditions when *machæralis* is scarce, and about 27 plants supporting the recently introduced *Cedria paradoxa* for conditions when *machæralis* is abundant; the 7 plants supporting *Goniozus montanus* parasitic on *puera.*

In a third class of usefulness are those plants that support defoliators which are the hosts of *machæralis* parasites having only one other host, *e.g., Diospyros montana, Ehretia lævis* and *Solanum* sp.

From the table of plant associates of teak given above it is evident that the natural control of *H. puera* by auxillary parasites is less extensive than that of *H. machœralis.* For *H. puera* the most important auxillary plant is *Holharrena antidysenterica* which supports the alternative host of *Sturmia inconspicuella,* often the most abundant parasite of *H. puera.*

The following species of plants are *undesiralle* in teak plantations because they are alternative food-plants of *machæralis* or *purea* or of other pests of teak : –

Plant.	*Defoliator.*	*Borer.*
Callicarpa arborea	Hyblæa puera	
Callicarpa lanata	Hyblæa puera	
Gmelina arborea	Eupterote germinata Eupterote undata	Dihammus cervinus Phassus malabaricus
Macaranga roxburghii		Phassus malabaricus
Premna latifolia	Hyblæa puera Pagyda botidalis	
Vitex negundo	Diacrisia obliqua Eupterote geminata Hyblæa puera	
Vitex peduncularis	Hyblæa puera	
Lantana camara	Diacrisia obliqua Hyposidra successaria Hyposidra talaca	Phassus malabaricus

* The term "useful" as employed above is relative to "neutral" and "undesirable." It is not possible to measure it by any other standard than ability to support desired parasites; as with all biological control factors its value is constantly fluctuating.

Parasites in the Biological Control of Teak Defoliators

Our investigation of the natural parasitism of *Hapalia machæralis* and *Hyblæa puera* continues to yield previously unrecorded species of parasites, but their identification is not progressing as quickly owing to the shortage of specialists working on the groups involved. Below is given a statement of the distribution of those species that have been named; a very much larger number of species still remains unnamed.

NW means north-western region (Dehra Dun and palæarctic region); *C* means Central India; *S* South India; *E* Bengal, Burma and Malaya; *X* means indigenous; (*X*) means introduced artificially. Species in heavy type are common to both *machæralis* and *puera*.

PARASITES OF HAPALIA MACHAERALIS

Species	N W	C	S	E
BRACONIDÆ				
Apanteles machæralis	x	x	x	x
Apanteles ruidus	x	x	..	..
Cedria anomala	..	..	..	x
Cedria paradoxa	x	..	(x)	(x)
Cremnops desertor	x	..	x	x
Phanerotoma hendecasisella ..	x	..	x	x
CHALCIDOIDEA				
Brachymeria euploeae	x	x	x	x
Brachymeria nephantidis ..	x	..	x	..
Elasmus brevicornis	x	..	x	x
ICHNEUMONIDÆ				
Anomaloctenus melleus	..	..	x	x
Cremastus hapaliæ	..	x	x	x
Dioctes argenteopilosa ..	x	x	x	x
Mesochorus indica	..	x	..	..
Pristomerus microdon	..	x	..	..
Trophocampa indubia	x	..	..	x
Xanthopimla cera	x	x	..	x
TACHINIDÆ				
Actia aberrans	..	..	..	x
Actia hyalinata	..	x	..	x
Carcelia zetterstedti	x	..	..	x
Dolichocolon orbitale	..	x	x	..
Eutachina civiloides	x	..	..	x
Exorista heterusiæ	..	x	x	..
Hapaliolæmus machæralis ..	x	x	..	..
Nemorilla floralis	..	..	x	x
Ptychomyia remota	..	x	..	x
Sturmia inconspicuella	x	x	x	x
Sturmia nigribarbis	..	..	x	x
Sturmia parachrysops	..	x	x	x
Sturmia zebina	..	..	..	x
Zenilla roseanellæ	..	..	..	x

PARASITES OF HYBLAEA PUERA

Species	Distribution			
	N W	C	S	E
BETHYLIDÆ				
Goniozus montanus	x	..	x	(x)
BRACONIDÆ				
Apanteles hyblææ	..	..	..	x
Apanteles malevolus	x	..	..	x
Apanteles puera ..	..	..	..	x
CHALCIDOIDEA				
Brachymeria euplϾ	x	x	x	x
Brachymeria obscurata	..	..	x	x
Elasmus brevicornis	x	..	x	x
Elasmus hyblææ	..	..	x	..
Elasmus johnstoni	x	x	..	..
Trichogramma minutum ..	x	..	(x)	x
Trichogramma sp. Burma ..	..	..	(x)	x
Trichospilus pupivora	..	..	x	x
ICHNEUMONIDÆ				
Dioctes gardneri	..	..	x	(x)
Echthromorpha notulatoria ..	x	x	x	x
Hemipimpla rugosa	..	..	..	x
Theronia zebroides	..	..	..	x
TACHINIDÆ				
Actia hyalinata	..	x	..	x
Eucarcelia kockiana	x	x	x	x
Eutachina civiloides	x	..	..	x
Ptychomyia remota	..	x	..	x
Sturmia inconspicuella	x	x	x	x
Tachina fallax	..	..	x	x
Winthemia albiceps	..	..	x	x

Introduction of Parasites to Nilambur

An insectary was maintained by the Forest Research Institute at Nilambur, Madras, from April to November, 1937, for the purpose of introducing and colonising parasites of teak defoliators.

Cedria paradoxa: About 1,000 individuals of this species were imported from Dehra Dun in March 1937, and from this stock 5,000 cocoon-colonies representing over half a lakh of parasites were produced in the Nilambur insectary. In August and September, 24,000 parasites were released mainly in areas where *Helicteres isora* was being defoliated by *Lygropia*, and in October, November, 16,000 parasites were released mainly in compartments where *H. machæralis* was beginning to increase.

In November 1937, cocoons of *C. paradoxa* were recovered on *Helictere isora* and in April 1938 cocoons were recovered on fallen teak leaves indicating that the parasite had passed through several generations after the liberation of the initial colonies.

A colony of 500 parasites was successfully shipped to Burma and this stock has since been multiplied and colonised.

Trichogramma minutum: Material from wild egg-masses of *Diacrisia obliqua* and from flour moth eggs supplied by the Government Entomologist, Mysore, was multiplied in 23 generations and 9,250 parasites were released in four localities in teak and mahogany plantations. This species did not breed in eggs of *machæralis* but *puera* eggs yielded two or three individuals per egg. The egg of *Hypsipyla robusta* is also used by *T. minutum*.

The Forest Entomologist, Burma, sent fifty-three lots of teak defoliator parasites to Nilambur; these were transported in cold storage by ship between Rangoon and Madras and by rail from Madras to Nilambur; the journey from Insein to Nilambur took five days.

We were unsuccessful in colonising the *Apanteles* and tachinids parasitic on *puera* owing to the prevalence of wilt disease in *puera* in the field and to the smallness of the insectary stock of each species of parasite.

An unnamed egg-parasite, *Trichogramma* sp., from Burma, was bred with difficulty on eggs of *puera* and a small colony was released at the close of the operations.

The efficiency of the control of *H. machæralis* by parasites in Nilambur is much greater than that of *H. puera*. Further work is necessary on the parasites of *puera* to ensure effective biological control in seasons when wilt disease is not epidemic. Through the courteous co-operation of the Forest Department, Burma, it should be possible to introduce to India those species that are at present unrepresented.

TIMBER PRICE LIST, JUNE-JULY 1938

(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Assam ..	Logs ..	Rs. 30-0-0 per ton in Calcutta.
Benteak ..	*Lagerstrœmia lanceolata*	Bombay ..	Squares ..	Rs. 36-0-0 to 80-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-4-0 per c.ft.
Bijasal ..	*Pterocarpus marsupium*	Bombay ..	Logs ..	Rs. 42-0-0 to 84-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-6-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-4-0 per c. ft.
Blue pine ..	*Pinus excelsa* ..	N. W. F. P.	12′×10″×5″ ..	Rs. 4-5-0 per piece.
,, ..	,, ..	Punjab ..	12′×10″×5″ ..	Rs. 5-0-0 per piece.
Chir ..	*Pinus longifolia* ..	N. W. F. P.	9′×10″×5″ ..	Rs. 2-0-0 per piece.
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	
,, ..	,, ..	U. P. ..	9′×10″×5″ ..	Rs. 3-4-0 per sleeper.
Civit ..	*Swintonia floribunda* ..	Bengal ..	Logs ..	Rs. 25-0-0 per ton.
Deodar ..	*Cedrus deodara* ..	Jhelum ..	Logs ..	
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	Rs. 4-2-0 per piece.
Dhupa ..	*Vateria indica* ..	Madras ..	Logs ..	
Fir ..	*Abies & Picea* spp. ..	Punjab ..	9′×10″×5″ ..	
Gamari ..	*Gmelina arborea* ..	Orissa ..	Logs ..	Rs. 0-10-0 to 1-4-0 per c.ft.
Gurjan ..	*Dipterocarpus* spp. ..	Andamans ..	Squares ..	
,, ..	,, ..	Assam ..	Squares ..	Rs. 50-0-0 per ton.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 30-0-0 to 35-0-0 per ton.
Haldu ..	*Adina cordifolia* ..	Assam ..	Squares ..	Rs. 1-2-0 per c.ft.
,, ..	,, ..	Bombay ..	Squares ..	Rs. 24-0-0 to 68-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-13-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-3-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-9-0 per c.ft.
Hopea ..	*Hopea parviflora* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Indian rosewood ..	*Dalbergia latifolia* ..	Bombay ..	Logs ..	Rs. 52-0-0 to 100-0-0 per ton.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-12-0 to 1-4-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 2-2-5 to 3-12-0 per c.ft.
Irul ..	*Xylia xylocarpa* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Kindal ..	*Terminalia paniculata* ..	Madras ..	Logs ..	Rs. 1-4-0 to 1-5-6 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 36-0-0 to 72-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-10-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-12-1 to 0-14-2 per c.ft.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	Rs. 1-2-9 to 3-14-0 per piece.
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 50-0-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-3-0 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 20-0-0 to 75-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Rs. 0-8-0 to 1-3-0 per c.ft.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 to 5-0-0 per sleeper.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 1-10-0 per sleeper.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-0-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-0-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-14-3 to 5-4-0 per sleeper.
Sandalwood	*Santalum album* ..	Madras ..	Billets ..	Rs. 325-0-0 to 890-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Rs. 1-8-0 to 1-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-6-0 to 1-0-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 30-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	Rs. 1-0-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Rs. 0-12-1 to 1-1-10 per piece.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-0-0 to 1-6-6 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class	
,, ..	,, ..	,, ..	Logs 2nd class	
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-9-9 per c.ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 2-3-3 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-13-11 to 2-15-0 per c.ft.
,, ..	,, ..	Bombay ..	Logs ..	Rs. 68-0-0 to 140-0-0 per ton.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 3-8-0 each.
White dhup.	*Canarium euphyllum* ..	Andamans ..	Logs ..	

SAL INFLORESCENCE

SIR,

Mr. Davidson notes in the May number of the *Indian Forester* that he has observed pink flowers more commonly in the D-3 Eastern Terai Sal in the wet types of forests, commonly near the streams. In Goalpara district, I have seen sal trees standing side by side, not near any water, one carrying pink flowers, one cream and the third intermediate between the two.

As for durability, the common belief is that redder wood is more durable, and I have not heard it said that it was inferior in quality as it cracked after sawing when kept exposed.

R. N. DE, I.F.S.,
Silviculturist, Assam.

REVIEWS

FOREST ADMINISTRATION REPORT OF THE ANDAMANS FOR 1936-37

Working Plans.

1. The bringing into force of the new Working Plan, marking the end of the long period of unregulated fellings, was the outstanding feature of the year under review. At the same time, the forests were brought under the provisions of the Indian Forest Act.

Silviculture.

2. Having solved the problem of obtaining natural regeneration of the more valuable species, the next problem is to reduce the cost of the regeneration and it is to this end that the efforts of the staff are now being directed.

3. The lines on which this problem is being tackled are:

(*a*) *Speedier removal of the overwood.*

Attempts are now being made in the deciduous forests to reduce the regeneration period and to follow up the seeding felling by one final felling. The results so far are distinctly promising and in the areas in which this experiment is being tried, it appears that so rapid is the response of the young regeneration to the admission of

full overhead light that, despite the more luxuriant growth of weeds, it may well be found feasible, over considerable areas of the deciduous forests, to shorten the interval between the seeding felling and the removal of the overhead canopy to one year and to complete the latter in one operation instead of, as hitherto, in two or more operations. The reduction of the secondary fellings to one final felling would effect a very considerable saving in expenditure.

(b) The regeneration of the forest in strips referred to in last year's report.

Under this system, the regeneration operations are confined to 40 feet wide strips at intervals of 30 feet, no fellings of any kind being carried out in these intervening 30 feet strips.

While it is yet too early to draw any definite conclusions, a serious disadvantage of the system is the difficulty of demarcating the strips in country at all broken. More particularly where, as is the case here, expert supervision is not available. For this reason the system cannot be applied to the areas to be regenerated in the current year.

4. Apart from the above difficulty, it remains to be seen to what extent the development of the seedlings on the margins of the strips is affected by the side shade of the standing forest. A further danger is the invasion of the regeneration strips by climbers from the unworked strips. It is, therefore, yet to be seen whether the initial saving in the cost of regeneration under this system will be more than offset by the subsequent increase in the cost of establishing the young crop.

5. The total area taken up for regeneration in the year under review was 793 acres as against the minimum area of 640 acres prescribed in the Working Plan.

6. Intimately connected with the question of reducing the cost of regeneration is that of the labour supply, the unsatisfactory position in respect of which is revealed by the postponement of the thinnings in the older plantations on account of shortage of labour. With the withdrawal of convict labour, reliance has, to an increasing extent, to be placed on imported free labour and while such labour is obtainable from Ranchi, it is expensive and temporary and not very suitable for most forest work here.

7. The only satisfactory solution of the labour difficulty lies in the establishment of a resident labour force and past efforts in this direction have shown how formidable are the difficulties in establishing such a force for forest work in these islands. The labour difficulty has, however, now assumed such serious proportions that no effort should be spared to tackle this problem and every inducement should be made to attract labour, suited to forest work, to settle permanently in the islands.

Exploitation.

8. A highly satisfactory feature of the year's operations is the success of the experiment of extracting the logs by tramways, using elephants for the motive power. The experimental tramline, laid in the Rangat valley, has shown that by these means the costs of extraction, with a 4-mile lead, are no more than those of dragging by elephants with a lead of only ½ to 1 mile. In the past, extraction was confined to the fringes of the forests bordering the floating streams or to the coastal areas within ½-1 mile of a safe anchorage. Now that such areas have largely been depleted of the mature valuable species, the importance of the development of a means of working economically beyond these fringes needs no emphasis. Two such tramway schemes have now been prepared—one for working the Lurujig basin on Baratang island and the other for working the forests to the north of Rangat in the middle Andamans. An interesting account of the method of extraction by tramways in conjunction with elephants appeared in the December 1937 issue of the *Indian Forester*.

9. The volume extracted during the year under review amounted to 36,835 tons which compares with 38,142 tons extracted in the previous year. There was little change in the proportion of the various species extracted, hardwoods representing 60 per cent. and softwoods 40 per cent. of the total volume extracted. The volume of padauk extracted—by far the most valuable species—remained at practically the same figure as in the previous year—4,923 tons as against 4,963 tons.

Milling.

10. The total volume of logs sent to the Chatham sawmill for conversion was 23,120 tons as compared with 25,903 tons in the previous year, the total outturn of sawn material being 10,196 tons as compared with 11,698 tons in the previous year.

The rise in the wastage per cent. from 54.84 to 55.90 was due to the larger volume of softwood logs sent to the mill for conversion on account of their unfitness for sale in the round as matchwood logs owing to various defects.

11. The North Andaman remained closed throughout the year. No acceptable offers were received for the purchase of the machinery of the mill in response to the sale advertisement inserted in Press.

12. The following statement compares the volume of timber sold in the various markets with that in the previous year:—

Market.	1936-37.			1935-36.		
	Logs.	Squares.	Scantlings.	Logs.	Squares.	Scantlings
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Calcutta ..	5,271	1,705	3,807	4,542	1,913	4,463
Madras ..	1,582	..	2,653	2,071	..	2,781
Rangoon ..	1,254	..	1	3,112	..	..
London ..	33	85	850	8	192	823
Bombay ..	1,774	21	230	2,925	222	..
Others ..	..	22	..	..	18	..
Local ..	3,081	4	752	130	1	544
Total ..	12,995	1,837	8,293	12,788	2,346	8,611

Logs.—Sales were well maintained, the total volume sold stood at 12,995 tons, being 107 tons more than in the previous year. The re-opening of the Port Blair match factory accounts for the increased sales in the local market and for the decrease in the Madras and Bombay markets. The reduced sales in Rangoon were due to a falling off in the demand for matchwood logs owing to cheaper local supplies being available.

Squares.—The total volume sold fell from 2,346 tons in the previous year to 1,837 tons, this fall being due to the low prices ruling for gurjan squares, to less demand for silver-grey wood squares in the London markets and to less padauk being available for sale in the form of squares.

Scantlings.—The total volume of scantlings sold was 8,293 tons, as compared with 8,611 tons in the previous year. The largest decrease was in the Calcutta market but was more than compensated for by increased sales of round logs. As the latter yield a profit instead of a loss, as in the case of scantlings in this market, the reduction in the sale of the latter is to be welcomed.

Financial results.

13. The financial results of trading in the various markets are summarised below and compared with those of the previous year:—

Markets.	1935-36.			1936-37.		
	Logs.	Squares.	Scantlings.	Logs.	Squares.	Scantlings.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Calcutta ..	36,920	49,337	—38,888	41,783	19,386	—24,487
Madras ..	19,619	..	27,125	16,490	..	30,182
Rangoon ..	29,124	..	..	10,860	..	—8
London ..	279	12,827	29,565	851	5,568	20,806
Bombay ..	28,713	14,295	..	19,253	1,118	1,507
Others ..	..	437	..	..	1,863	..
Local ..	1,846	72	18,067	33,725	202	22,792
Total ..	1,16,501	76,968	35,869	1,22,962	28,137	50,792

As the details of the species and sizes of the sawn material sold in the various markets are not given in the report, it is difficult to assess the results of the sales, particularly in respect of scantlings. The above figures show that scantlings continue to be marketed in Calcutta at a loss, although there has been a marked improvement in this respect. It is, however, to be borne in mind that not only is the Calcutta market extremely competitive but it also serves as the main outlet for sawn timber, which fails to qualify for export to other markets and for the disposal of sawn timber of species not saleable in other markets.

14. Taking the total receipts in all markets, the profit on logs averaged Rs. 9.46 per ton, on squares Rs. 15.32 per ton, and on scantlings Rs. 6.12 per ton.

Owing to changes in the method of calculating the costs of production, no comparison can be made with the corresponding figures of the previous year.

15. The revenue realised during the year was Rs. 13,16,471 against an expenditure of Rs. 9,44,852, leaving a cash surplus of Rs. 3,71,619.

16. The balance sheet of the year shows a profit of Rs. 1,07,936. This profit is arrived at after making the following adjustments:

	Rs.
Interest on capital	75,037
Depreciation on assets	87,822
Leave and pension contributions ...	17,843
Audit fees	6,000
Total	1,86,702

Including the interest—Rs. 75,037—which in a joint stock company would be available for appropriation towards the payment of dividends, the profit of the year represents a return of 11.3 per cent. on the invested capital.

General Administration.

17. The valuable services of Rao Sahib B. S. Chengappa were recognised in the Coronation Honours List.

On the reversion of Mr. S. K. Basu to Madras, the post of the Divisional Forest Officer, South Andamans, was not filled up. Orders of the Secretary of State abolishing this post and creating in its place the post of Assistant to the Chief Forest Officer were received after the close of the year.

L. M.

ADMINISTRATION REPORT OF THE FOREST DEPARTMENT OF THE CENTRAL PROVINCES AND BERAR FOR 1936-37

With a total revenue of Rs. 47.63 lakhs and an expenditure of Rs. 36.39 lakhs, the Forest Department of the Central Provinces and Berar produced a net surplus of Rs. 11.24 lakhs in the year 1936-37. This was Rs. 2.76 lakhs less than in the preceding year, and was due to an increase of Rs. 1 lakh in expenditure (Rs. 0.75 lakhs on expansion of departmental operations in the Eastern and Western

Circles, and Rs. 0.43 lakhs on increments in time scales of pay), combined with a decrease of Rs. 1.76 lakhs in revenue (Rs. 0.77 lakhs in grazing dues and the remainder under all other revenue heads except "Other Produce" and "Forest Tramways"). Improvement in prices of standing coupes and larger collections of grazing dues at the close of the year indicate that the set-back in revenue was probably only temporary; although if grazing rates are reduced, to afford relief to the cultivators, a further decrease of revenue under this head is to be expected. The extent to which such a policy may affect the totals can be judged from the figures for the year under report, in which Grazing and Fodder Grass alone accounted for Rs. 12.74 lakhs revenue, compared with Rs. 20.74 lakhs for timber.

The extent of the grazing, and also the free grants and concessoins, which are valued at Rs. $14\frac{1}{2}$ lakhs, demonstrated clearly the utility of the forests to the people living in their vicinity. The necessity and scope of fodder development is manifest in all Provinces in India and it is becoming increasingly realised that forestry is not an isolated subject, but is an integral part of the general land use policy. The Forest Department of the Central Provinces and Berar is not behindhand in this realisation—experiments are in progress to study grazing incidence and closure, and in the meantime grazing facilities have been recently increased by reducing the period of closure.

It is satisfactory to note that all the forests in charge of the department have been stock-mapped and that by the close of the year all divisions would have carefully prepared working plans. This is a very good record of work, for which the department is to be congratulated. The need for the post of the Superintendent of Working Plans and Research, which was abolished as a measure of economy in October 1932, is now badly felt and it is to be hoped that this very important post may soon be revived.

Conversion operations in both the teak and sal forests have been generally successful. But frost continues to cause damage in lowlying areas, while coppice shoots of sal are badly browsed by cheetal and sambhar in the North Chanda forests. These animals cause extensive damage in plantation and regeneration areas, and to keep them down and to maintain the correct balance of power in nature, it becomes necessary for the Forest Officer to protect the tiger to some

extent. Lantana is a pernicious pest in several divisions. The caterpillar *Diacrisia obliqua* was employed to eradicate it, but proved to be an undependable ally, owing to its partiality for several other shrubs.

The problem presented by the untrained staff has been rightly stressed in the report. It is impossible to get good work out of them. Forest work may appear simple and "jungli," but actually forestry is technical and not like the village cart which anyone can drive.

Forest guards are sometimes subjected to criticism for irregularities committed by them in exercising the legal powers vested in them by the Forest Act. But it does not seem to have been sufficiently realised that the sense of responsibility and duty in an officer is often in direct proportion to his status, which can be interpreted in terms of the conditions in which he is made to work, his emoluments and his future prospects. There is no denying the fact that the Forest subordinates, and particularly the forest guards, are extremely low paid, and also that many of them not only have to work in fever-ridden forests, but are without any Government quarters. It is distressing to note that 884 forest guards in a department which produced a net profit of Rs. 11 lakhs, return in the evening after a hard day's work to no home, but have to live in huts "scarcely fit for human habitation." The death of 39 poor forest guards in a single year is also a very serious matter, and is doubtless related in part, at any rate, to the poor housing conditions. It is to be hoped that the revised 5-year building programme which has been submitted to the Government, will be sanctioned and that liberal grants will be made to ensure its satisfactory completion.

A. R. S.

ORNAMENTAL AND FLOWERING TREES FOR AVENUES AND PARKS

Visitors to India have often been struck by the lack of imagination displayed by Government, Municipal and District Board officials and private individuals too, for that matter, when selecting trees for shade or for improving the appearance of a station.

This is particularly so in the case of the compounds of Government offices and along the margins of trunk roads. "Let's plant a tree" seems too often to be the attitude and in goes a *Ficus,* a mango, a *litchi* or even a *simul* tree. It does not seem to be of importance whether the tree has leaves in the hot weather, when shade is most needed, or whether it possesses showy flowers.

When Government officials plant trees one fears that too often the æsthetic is submerged by materialistic motives. Mango and *litchi* trees are expected to give a return when they grow up, hence their ubiquity.

Now the mango can grow into a fine umbrageous tree and no one will deny the succulence of its fruit or of that of the *litchi.* A fine mango tree inevitably causes one's thoughts to stray towards visions of iced mango or "mango fool." But surely a beautiful tree should be expected to have more effect upon us than the mere stimulation of the salivary glands. Let us have something with more colour, something more striking, something that leaves a deep impression on the mind.

Examples of what can be expected from the judicious planting of roadside trees are to be seen at the Forest Research Institute, Dehra Dun. The Jacaranda avenue in full bloom is a sight never to be forgotten. Trevor Road with its rows of *Lagerstrœmia flos-reginæ* trees in full flower has caused more than one observer to look with kindly interest on the brain-fever bird or to believe that prickly-heat is what the doctor ordered.

On the other hand, can anyone say with truth that our high roads, outside reserved forests, are attractive? Taking them by and large our roads are singularly ugly and this in a climate where the most beautiful of tropical trees can be got to grow.

Rest-house compounds too might be made a great deal more attractive to the jaded traveller. Surely something better than the inevitable mango, the pumelo, *Aegle marmelos,* the tamarind and others could be planted to beautify the surroundings?

It is with great satisfaction, therefore, that we learn of the initiative of the Silviculturist, Central Provinces, in establishing a nursery of ornamental trees at Nagpur.

The nursery is intended primarily to satisfy the demands of the Nagpur Improvement Trust but plants are for sale to other departments and private individuals at a ridiculously cheap rate. A booklet has been issued which contains the names of the species and notes regarding their suitability for avenues, parks, and so on.

We hope that the departments and individuals to whom the appeal is directed will take advantage of this opportunity and in doing so, we wish Mr. Sagreiya all fortune in his arboricultural campaign.

[We have referred to Mr. Sagreiya's useful pamphlet on "Ornamental and flowering trees for avenues and parks" in the Editorial Notes.—Hon. Ed.]

N. L. B.

FOREST DISTRIBUTION MAP OF GERMANY

A large-scale forest distribution map of Germany measuring about $5' \times 4'$ has been compiled by Professor Dr. Ing. Franz Heske of the Forest High School of Tharandt and published by J. Neumann, Neudamm of Berlin. It shows in green colour the forested areas of Germany, rivers and lakes being in blue and the remainder of the country in white. Accompanying the map is a pamphlet giving details regarding the distribution of the different types of land utilization in Germany. Agricultural land forms 63 per cent. of the total, land under forest management 27 per cent. and unutilizable land areas of water roads, railways, parks, towns, etc., together comprise the remaining 10 per cent. The total forest area of the German Reich is about 12,654,200 ha. A conifer forest forms 71 per cent. of the forest area while broad-leaved forests are only 29 per cent. The broad-leaved trees are chiefly found in western Germany and conifers in the east and south-east. Further details by provinces are given and a short history of the development of the forest distribution of Germany completes the pamphlet.

M. V. L.

EXTRACTS

RAYON EXPERIMENTS FOR BOMBAY

In the last session of the Bombay Assembly, the Hon. Mr. A. B. Latthe, Finance Minister, moved the following resolution: "This Assembly approves of the scheme embodied in the budget for 1938-39 for making experiments for introducing the rayon (artificial silk) industry in this province at a cost not exceeding Rs. 75,000."

Mr. Jhabvala moved an amendment adding that the Assembly was strongly of the opinion that Government must introduce a system of making experiments for the success of important key industries in the province.

Speaking on the motion, the Finance Minister said that Government was waiting for the result of an enquiry undertaken by the Indian Central Cotton Committee regarding the development of the rayon industry. That enquiry was, however, confined to production of artificial silk from cotton. Experience all over the world had shown that the artificial silk produced from cotton was more costly, and that a better method was to make it by the wood-pulp process. Government had decided to experiment with the latter process.

India's import of rayon.—The Minister pointed out that India was importing artificial silk yarn to the extent of Rs. 4,00,00,000. If the experiment succeeded and they were able to develop the industry all that money could be saved.

With regard to Mr. Jhabvala's amendment, although he did not think it necessary, he was willing to accept it.

Mr. Jhabvala said that before thinking of the rayon industry Government should have carried on experiments to develop other smaller industries.—(*Commerce*, 21st May 1938.)

PLANT INDICATORS

By V. N. BALANDIN

Conclusions

Modern plant physiology and ecology prove convincingly that a vegetative organism is very adaptive to the environment, wherefore

one and the same species may be found under the most varied conditions. Besides, we must bear in mind that on more accurate research a series of species proved to be differentiated into a number of ecological races and frequently even races which differ from each other in their morphological properties.

On the other side, a number of species are frequently included in this or that group, mesophytes, xerophytes, and halophytes, in a purely mechanical way because of a strictly formal character of the plant towards environment without any deeper analysis of their reciprocal relations and the history of the development of the species in question.

Purely mechanical also are certain rather wide-spread opinions whose conception is that this or that species or group of species may be considered as similar to universal reactives by the presence or absence of which we may easily determine the soil qualities and its chemical and mechanical structure or as a means by which one may easily form an opinion concerning the "character of moisture and nearness of ground water."

If we recognize the complete inconsistency of such simplified conceptions and theories, ought not phytogeographers refuse to participate in the socialistic reconstruction of our country and devote ourselves exclusively to the collection of factual material and its elaboration, the working out of the theoretical questions and the introduction of Marxist-Leninist methods into phytogeography which has been in need of them for a long time?

Such a formulation of the question is, of course, radically wrong. Phytogeography can and must take an active hand in the solution of a whole series of the most important questions connected with our socialistic work.

We must, however, abandon the incorrect construction and formulation of many questions; we must cease overestimating "the so-called phytometrical methods" by means of which the vegetation is used as an indicator of its environment; we must give up the primitive theory of plant indicators "based on the formal relations of plant and environment.".

There are not and cannot be in existence any plants that are universal indicators of swampiness, salinity, etc. of soils just as certain data concerning annual precipitation cannot serve as indicators of the climatic regime, or just as it is impossible to classify a soil as to type on the basis merely of the humus content or its mechanical structure.

It is not the black wormwood which is an indicator of crusty, columnar Solonetz soils nor the narrow-leaved *Agropyrum* of sands, nor any other individual plant of the Chestnut soils, but certain elements of the vegetative cover, groups of plants, phytocoenoses, associations in which the above-named plants occur together with a great many components. These phytocoenoses are characterized by definite quantitative relations between the species, by layerings, change of aspects, etc. and adapt themselves to certain climatic soil zones and vegetative formations, to certain topographical factors and depend on the geological past and on the economic activity of man. On the crusty, columnar Solonetz soils representing different variants of the south-eastern graminaceous prairie, we find species of *Stipa, Poa bulbosa* L., some species of mosses, lichens and algae and not black wormwood alone. It is not merely halophytes that are typical of saline soils but a number of other plants which belong to most diverse forms. About the salinity of soils we are able to form an opinion not only by the presence of certain halophytes but by the quantitative relationship between the species, the degree of their vitality, etc.

The differentiation of the various elements of the vegetation cover and their separation on the map by definite contours must be based not on the presence or absence of certain species but on a thorough study of the various plant associations. The distribution of the various species and the frequency of their occurrence is only one of the factors, not the exclusive one, which characterizes the soil cover.

In some cases such plant associations may consist of only five or six species but all these are primitive, initial phytocoenoses; others, however, will have a more complicated structure and be distinguished by an abundance of species as we observe, for example, on various meadows subject to inundation, on mountain meadows, and in forests.

Only in such a connection and in this way the question can be solved correctly and the phytogeographical map will become an almost accurate mirror of the soil map and *vice versa*. In that case the phytogeographical map will simply become a mechanical reproduction of the soil map.

Generally speaking, there exists a certain, rather definite relationship between certain soil types and the vegetative cover. But even under very similar climatic and geomorphological conditions (of course, also under similar conditions of economic utilization) soils of very similar types and slight differences may have a vegetative cover greatly differing from a floristic standpoint. This takes place because some species have not as yet reached the natural boundaries of their area of distribution and therefore do not occur in the given association because the climatic and soil conditions are not quite suited for them. This, for example, explains the fact that in some portions of the Near-Manych steppe we find the saline plant *Anabasis aphylla* L. quite commonly amidst associations consisting of wormwood and graminaceous plants while on other sites with very similar ecological, climatic and geomorphological conditions it is not to be found. In the same way, evidently, we must explain the absence of black wormwood (*Artemisia pauciflora* Webb.) on crusty, columnar Solonetz soils in the western part of the Near-Manych lowland steppe [near the western end of the Bolshoi Liman (great estuary)].

Aside from this, distinct differences in the floristic composition of the vegetative cover, in spite of the great similarity of the same, are explained by other factors, for example, the transformation of associations in the forest zone as the replacement of the pine by the spruce in spite of the unchanged or only slightly changed soil cover and climate.

Besides, a very important factor bringing about considerable changes in the vegetative cover is animal activity. Very frequently such changes are due in the prairie zone to the activity of marmots, bobcats, jerboas, and larger herbivorous, ungulate animals.

Passing then to field vegetation consisting mainly of weeds (but not to the individual species of weeds) we must say that this type of vegetation may serve as an indicator. Weed vegetation, however,

depends to a very great extent on the economic activity of man, and the influence of climate and soil affect it to a smaller degree. It is not an accidental phenomenon that, amidst the species with very large, almost cosmopolitic areas of distribution, there occur a great many species of weeds, that is to say, of 117 species occupying a fourth of the surface of the earth, 30 or about 26 per cent. are weeds. The most widely distributed species are *Capsella bursapastoris* Moench., *Salsola kali* L., *Amarantus retroflexus* L., *Xanthium spinosum* L., *Thlaspi arvense* L., and *Chenopodium album* L. For this reason we must approach the conclusions on the basis of the weed vegetation very cautiously. In this case again it is not the individual species but their groups; definite groupings of weed species, ecological series, characteristic phytocoenoses composed both of weeds and cultivated plants may yield very valuable data after they are studied in connection with site conditions and considering the conditions of economic utilization: when this is done they may be utilized not only with a view of combating them directly but determining also their areas of distribution and studying the dynamics of the soil processes connected with them, for example, the influence of drainage and irrigation.

The same may be said concerning plants which serve as indicators of overgrazing. These may really be called grazing weeds. It is not by the presence or absence of this or that species in a pasture or meadow that we may form an opinion of the condition of the given area but only by a definite association connected with definite site conditions, a definite soil structure, a definite transformation of aspects, and a definite history of economic utilization.

In expressing his ideas on the question of plant indicators, the author believes that a correct formulation and solution of that question is closely connected with the elaboration of the fundamental methods and with a thorough reconstruction of phytogeography on the basis of the Marxist-Leninist theory, in which the great majority of the botanists of our country take a most active part. —(*Reprinted from Division of Silvics, United States Forest Service, Translation No.* 304.) (*Sovietskata Botanika* 6: 27-35. *Moscow-Leningrad, U.S.S.R.*, 1936.)

STATE CONTROL OF PRIVATE WOODLANDS

The Council of the Royal English Forestry Society has recently submitted to the Forestry Commission a proposal that it should institute a service of forestry advisers who would devote their whole time to encouraging and assisting private owners to manage their woods more efficiently and to building up a forest sense in the British public. The framers of the proposal applied their ingenuity to devising a system of control which might satisfy Treasury requirements but at the same time ensure that a proper regard was paid to the special needs of private estates and to local conditions. They also tried to secure a happy relationship between the advisers and the voluntary organizations in their areas which are encouraging better forestry. These proposals were discussed at an important meeting which was called by the Forestry Commission early in February and are now under consideration by the Forestry Commissioners.

Any suggestion that the State should exercise any legal control over the management of private woodlands has been consciously omitted from these proposals, as the Council was anxious not to antagonize existing interests. But subsequent discussion has shown that there is a much more lively sentiment in favour of legal enforcement than had been supposed. This is not an isolated phenomenon but is part of a slow but profound change in the political outlook of the nation. It arises from the conviction that democracy must justify itself by its works and can no longer be content with a doctrine of laissez-faire: that what other countries can do we can do also. The insistence that private owners shall manage their land efficiently is not confined to the totalitarian States but is equally characteristic of such democratic countries as Sweden, Finland and Czechoslovakia; it is part of the demand for a more intelligent employment of national resources, a demand which transcends and is unconnected with adherence to any political party.

The demand for a measure of State control has already found expression in the pages of this Journal. In the last number Mr. Justice à Beckett Terrell urged that we should restrict fellings (making allowance for the special requirements of landowners, as is already done in Czechoslovakia) and insist that felled areas should

be replanted. The present number contains an article by Mr. Langley-Taylor which calls for more control by the Forestry Commission and the co-ordination of any new legislation with the powers already conferred by the Town and Country Planting Act, 1932, and certain road Acts.

Englishmen are strongly opposed to any unnecessary curtailment of their private liberties, and they zealously guard their independence. They have a strong case in opposing control when they point out that good organizers give their best in an environment, which is as free as possible from legal restraint, and that the time spent in filling up forms inevitably increases the cost of management. Legislation of this nature may, however, be introduced when the national interest demands it or when it may be beneficial to the industry through removing unfair competition or encouraging useful co-operation. The need for legislation in regard to private forestry must be considered in relation to these views. Our attitude to the subject must be based first of all on the present state of British forestry, and nearly all foresters will agree that this falls far below the standard which can be considered satisfactory. On a few estates they are managed with the care and forethought which they demand, but most owners neglect them more or less completely. And they excuse themselves on the ground that forestry does not pay, without waiting to think that no industry whatsoever can pay unless it is managed with knowledge and energy. On every estate where knowledge and energy have been applied to woodlands for a long continuous period forestry has proved itself to be a source of substantial profit, and on many estates to-day the owners are reaping the reward of periods of activity in the past. But for those who do not sufficiently care about the proper use of their land any excuse is sufficient to justify inaction.

Our next question must be whether this neglect is a matter of consequence to the nation. But surely there can be no question about this. A well-timbered country is a source of wealth and beauty. It gives profitable and healthy labour, supports local industries and provides a great store of material which in critical times we may not be able to replace by imports. To the owners themselves it gives security, and it encourages them to take a more profound and active interest in their land.

But even if the need for action is admitted it would still be better if our objects could be attained by propaganda and active encouragement rather than by legal enforcement. It is on this point that British foresters are divided: whether or no owners can be sufficiently aroused without State control.

Fortunately this is a question which may be tested out before any legislation can be usefully introduced. For legal measures, if they are to be effective, must be administered by a very carefully trained body of forest officers who are not only conversant with the silvicultural possibilities and the market conditions in the areas where they are stationed but are also sympathetic to the methods and difficulties of estate management. At present it would be impossible to recruit a sufficient number of competent men for such service, and it will take many years to train them. There can be no better way of training them than by adopting the scheme which our society has laid before the Forestry Commissioners, for this scheme gives them only the weapon of persuasiveness, a weapon which they must learn to handle. When they have mastered the use of this weapon and we can gauge the degree of its effectiveness, it will be time to decide whether greater powers should be given to them.

In the meantime there is much thinking to be done, and we should, in particular, make a detailed study of the methods which other countries have adopted to meet similar problems. Much on this subject has been published in Britain already, and a few principles common to many countries can be postulated. Thus Sweden and Finland have both laid down two basic regulations. The first is that, in order to prevent the fellings of immature crops, or irresponsible fellings which may masquerade as thinnings, owners must report intended fellings in time for them to be inspected before they are carried out. They are then visited by a forest officer who has power to refuse a licence. The second is that all felled areas shall be regenerated, either naturally or artificially. Both countries attempt further to secure that devastated woodlands and waste land shall be planted up, and Sweden has a generous system of subsidies and loans which encourage impecunious owners to improve their properties by this means. Germany goes very much further and even dictates the races of seed which shall be sown and the silvicultural system which shall be adopted.

The planting of woods is of little use unless they receive subsequent care and attention, and any scheme which aims at better forestry must also provide for small estates some means of competent supervision. There is a multitude of estates, mostly of small

area but some large, which have no adequate woodland staff and no competent forester in charge. The State advisers could be called upon to pay occasional visits to these estates, but, unless their number was very large, they could not be expected to manage an enormous number of scattered woods. It would be no exaggeration to suppose that some two million acres of private woods at present lack adequate supervision and, owing to the scattered nature of the woods, no forester should have to manage more than 5,000 acres, even with competent foremen under him. So four hundred is the minimum number of woodland managers required to secure adequate supervision for those private woodlands which are at present neglected, a number which greatly exceeds any probable recruitment for a national advisory service. The State must, therefore, look to other sources for a supply of woodland managers.

Three other sources suggest themselves. The first is the head foresters on neighbouring estates. Many estates have been so reduced in area by the sale of outlying portions that the retention of fully trained foresters has become uneconomic. If, however, their services could be shared by other owners there need be no difficulty in guaranteeing their salaries. The second is in the firms of woodland advisers and managers which have recently come into prominence in British forestry and provide competent supervision on a fee basis. With this group should also be included a number of individual foresters who undertake work of this nature. Finally there are the co-operative associations, such as the Scottish Landowners' Co-operative Forestry Society, and some branches of the Home-Grown Timber Marketing Association. In some European countries, and particularly in Germany, such co-operative associations are being very actively encouraged by government, and in Finland they receive special acknowledgment. They might, in Britain, take a very important part in the administration of laws which aimed at better forestry, as they would enable owners to engage their joint effort in securing the more efficient management which the law demands.

It is, therefore, desirable that the Forestry Commission should define more clearly its attitude to these co-operative organizations and explore the possibility of using them as a medium through which their projects for improving estate forestry might be in part operated.—(*Quarterly Journal of Forestry*, No. 2, Vol. XXXII, April 1938.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for May 1938:

IMPORTS

ARTICLES	MONTH OF MAY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
Siam ..	510	75	24	62,717	8,851	3,267
Burma ..	..	12,740	12,477	..	15,69,950	16,74,579
French Indo-China	296	65	149	29,189	6,427	19,195
Java ..	..	310	614	..	37,346	66,214
Other countries ..	..	35	..	..	6,786	..
Total ..	806	13,225	13,264	91,906	16,29,360	17,63,255
Other than Teak—						
Softwoods ..	1,379	1,217	1,279	80,576	88,424	92,132
Matchwoods ..	997	714	1,128	55,313	40,795	72,929
Unspecified (value)	..	..	..	46,394	2,31,356	2,88,705
Firewood ..	36	127	33	540	1,903	479
Sandalwood ..	45	..	19	12,667	..	2,919
Total value ..	..	..	..	1,95,490	3,62,478	4,57,164
Total value of Wood and Timber ..	..	..	..	2,87,396	19,91,838	22,20,419
Manufactures of Wood and Timber—						
Furniture and cabinetware ..		No data			No data	
Sleepers of wood ..	..	77	38	..	12,016	3,589
Plywood ..	221	428	466	55,747	1,00,093	86,699
Other manufactures of wood (value) ..	..	..	..	1,15,782	1,51,453	1,21,820
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	1,71,529	1,63,562	2,12,108
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	16,017	11,394	41,176	1,02,864	79,472	3,90,292

EXPORTS

ARTICLES	MONTH OF MAY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	4,305	1	..	9,41,789	350	..
„ Germany ..	274	..	..	63,557	..	..
„ Iraq ..	45	20	..	6,486	4,532	..
„ Ceylon ..	174	..	1	19,083	..	50
„ Union of South Africa ..	483	..	..	96,513	..	..
„ Portuguese East Africa ..	138	..	..	24,827	..	..
„ United States of America ..	..	..	..	..	..	..
„ Other countries	290	41	132	62,926	12,527	44,396
Total ..	5,709	62	133	12,15,181	17,409	44,446
Teak keys (tons) ..	349	..	..	50,664	..	..
Hardwoods other than teak ..	140	..	..	15,777	..	..
Unspecified (value)	..	..	..	72,318	4,02,475	30,160
Firewood ..	..	..	..	..	..	..
Total value ..	..	..	..	1,38,759	4,02,475	30,160
Sandalwood—						
To United Kingdom	1	1	..	1,000	1,800	..
„ Japan ..	..	..	2	..	..	2,150
„ United States of America ..	60	..	10	62,000	..	12,000
„ Other countries	45	54	15	55,383	57,330	16,785
Total ..	106	55	27	1,18,383	59,130	30,935
Total value of Wood and Timber ..	..	..	..	14,72,323	4,79,014	1,05,541
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	10,576	19,303	24,280
Other Products of Wood and Timber		No data			No data	

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STUDIES IN THE ECOLOGY OF THE SHOLA GRASSLAND VEGETATION OF THE NILGIRI PLATEAU

BY C. R. RANGANATHAN, I.F.S.

Abstract.—The natural vegetation of the plateau is a mixture of temperate evergreen forest (shola), its seres and grass. The grasslands are very extensive and are practically confined to the western plateau which is subject to annual ground frost. Here the shola is reduced to small, isolated woods occupying folds and hollows on the slopes. The shola is relatively more abundant on slopes protected from the morning sun. *The absence of fringing forest along perennial water-courses is a* feature of the frost zone. The study of altitudinal zonation shows shola to be the forest climax. Various considerations, such as its known antiquity and stability, indicate that the grass is also a natural climax. The relative distribution of the two climaxes is governed by the incidence of frost. Frost damage on the Nilgiris is confined to young plants and is probably a species of wilting effect due to plants exposed to the morning sun being unable to draw water from the frozen soil. The shola occupies slopes protected from the morning sun and sites where the danger of freezing is neutralised by abundant moving soil water. The grass though destroyed by frost revives quickly owing to its perennial root stock and its ability to spread vegetatively.

The vegetation of the Nilgiri plateau is of special interest to ecologists in that two distinct plant communities, evergreen shola forest and grassland, which are usually mutually hostile, co-exist on the plateau in close juxtaposition and apparent equilibrium. This phenomenon appears the more strange because the plateau possesses what would appear to be a typically forest climate. The presence of extensive areas of grassland in this climate has been something of a puzzle to botanists and foresters. The grass has been generally regarded as of secondary growth and as having usurped the territory previously occupied in the more or less remote past by evergreen forest which was destroyed by fire. Mr. Cox who knew the Nilgiris intimately—he later became the first Chief Conservator of Forests in Madras—was of this view and said in one of his notes to Government: "There is no reason why the whole of this rolling plateau should not be covered by dense forest . . . .

There is nothing in the altitude, rainfall or soil to explain the absence of forest, and if it is not due to grass fires I am completely at a loss to account for it." The purpose of this paper is to suggest an explanation for the joint occurrence of evergreen forest and grassland in this climate and to attempt to show that both formations represent climatic climaxes of their kind, and that their relative distribution is governed by a natural factor, the incidence of frost. The following observations relate to the Nilgiris (with which the writer is familiar), but similar conditions are said to exist on the Palnis and the Anamalais in South India and in Kenya.

FACTORS OF THE HABITAT

Physiography.—The Nilgiri plateau is an extensive plateau, about 35 miles long and 20 broad, with an average elevation of 6,500 feet above sea level, upheaved at the junction of the Eastern and Western Ghats which run southwards at a converging angle through the peninsula. The plateau is formed by a series of undulating hills and valleys which rarely rise much above or fall much below the average elevation of the tableland. It is divided east and west into fairly equal, but climatically dissimilar, parts by a range of hills running north and south and culminating in the Doddabetta. This hill, which is a familiar landmark from Ootacamund, is 8,640 feet high and, except by the Anaimudi Peak in Travancore, is the highest point south of the Himalayas. The western edge of the plateau is formed by a range of high hills called the Kundah range. Except for the Sispara pass in the south-west, the range constitutes an unbroken wall, rising frequently along its length to a series of elevated peaks most of which are over 8,000 feet high. The Kundah range acts as an effective barrier to the violence of the south-west monsoon, causing a steep gradient in the rainfall which falls from over 300 inches on the crests of these hills to less than 60 inches a few miles away on the protected plateau. A second interior range of hills running parallel to the outer rim further protects the Ootacamund basin from the rigours of the western winds. East of Doddabetta the country is much cultivated by an immigrant tribe of people called the Badagas. The ancient forests have been cleared and their place taken by cereal and potato crops or by fruit orchards and tea or coffee plantations. Where agriculture has been abandoned the ground is covered with a miserable scrub composed largely of *Rhodomyrtu*

tomentosa and *Dodonaea viscosa*. This part of the plateau is much subject to erosion. West of Doddabetta the Badagas are scarcer and the country consists of a sea of rounded grass hills, swelling here and there to prominent heights and ranges. These rounded hills are divided each from each by little streams or swamps, and in the folds of these hills are found sharply defined little evergreen woods known as sholas.

The plateau is drained by innumerable little streams most of which are perennial. This network of streams resolves itself into six principal river systems of which the largest and the most important are the Bhavani and the Moyar draining the eastern and western halves of the plateau, respectively. The Moyar empties itself into the Bhavani at the foot of the plateau so that ultimately the entire drainage of the plateau is carried by the Bhavani river.

The Nilgiri hills consist of a great mass of foliated gneissose rocks, of the class now termed charnockite, with a few later dykes of olivine-norites, from an inch to ten feet in width, which are well seen at Coonoor. There appears to be some reason for the belief that the whole of the plateau had been previously submerged by the sea. The undulations and rounded hills of the plateau are possibly result of marine action.

All over the plateau a blanket of soil, generally several feet deep, overlies the rock; outcrops of bare rock and rocky precipices are uncommon. The soils of the plateau may be classified under four heads: (*a*) the black, which is a rich loam and the best of all (the black peaty earth of the bogs, however, is useless until well worked); (*b*) the brown, a clay loam which comes second in productiveness but often lies on a dry and hungry lateritic sub-soil; (*c*) the yellow, a stiff clay which requires draining and is unsuitable for agriculture, and (*d*) the red soil which is not so stiff as the last but is equally unproductive. There is an entire absence of lime in all the soils.

Climate and rainfall.—The climate of the Nilgiri plateau is temperate and equable. At Ootacamund, for example, the average maximum and minimum daily temperatures are 65°F. and 49.5°F., respectively, with a mean of 56.9°F. At Coonoor the average is 6 degrees hotter. At Ootacamund there is only a difference of less than 9 degrees in the mean temperature of the coldest month, January,

and the hottest month, April. The average range of the thermometer during the year between the average maximum and the average minimum for each month is only 16.2 degrees, the maximum difference between these figures being 22 degrees in February and the minimum only 9.3 degrees in July. So far as *shade* temperatures are concerned, these statistics point to the Nilgiris possessing one of the most equable and temperate climates in the world. But, as is usual on tropical plateaux which owe the coolness of their climates to altitude and not to latitude, the intensity of solar radiation is very high and the daily range of temperature in the open very considerable. Plant growth on the Nilgiris is alternately exposed to the fierce glare of the noonday sun and the sudden drop in temperature which follows the setting of the sun. The absence of any indigenous conifers and indeed of any typically temperate vegetation as well as the comparative failure of efforts to naturalise European and Himalayan species on these hills is to be attributed mainly to the great range of daily temperature and the intensity of isolation all the year round. *Rhododendron* is a common species on the Nilgiris, but *Pinus longifolia,* its usual associate on the Himalayas, does not occur.

The first three months of the year are almost rainless and are a procession of bright clear days during which a dry wind blows from the north-east through January and February and veers round to the south-east in March. Frosty nights are common during the first two months. Thunder storms are frequent throughout April and May and the monsoon usually bursts about the second week of June. From June to the middle of August or sometimes later the south-west monsoon is blowing, giving heavy continuous rain on the Kundahs and the west of the plateau, and heavy showers alternating with Scotch mist at Ootacamund and the more inland situations. With a longer or shorter break in the weather the north-east monsoon follows, giving cyclonic rain, especially on the Coonoor and Kotagiri side (to the east of the plateau), and lighter rain at Ootacamund. In November and December over the western half of the plateau the skies are clear and ground frosts reappear, while on the eastern side of the plateau sunshine and rain alternate until the close of the year. General ground frosts are uncommon on the eastern half of the plateau because not only is the average elevation of the plateau about a thousand feet lower than that of the western half, and the

tendency for the incidence of frost consequently much lower, but frost is generally aborted even on the more elevated portions by the presence of cloudy skies during the winter months. This climatic difference between the two halves of the plateau is of great significance from the ecological point of view.

The Nilgiri plateau is shaped like a wedge with its apex to the south and is so situated that it gets the full force of both the monsoons. The western rim of the plateau generally and the north-eastern part of the plateau in the neighbourhood of Rangaswami Peak are, respectively, the principal foci for the south-west monsoon and the north-east monsoon. On the peaks of the outer range of the western hills the rainfall exceeds 300 inches per annum. Near Rangaswami Peak it is about 100 inches. The rainfall diminishes rapidly as we proceed into the interior of the plateau. The Doddabetta range in the middle of the plateau acts as a barrier to the free movement of the monsoon currents, dividing the plateau into two climatic zones, the western part receiving its principal rainfall from the south-west monsoon and the eastern part from the north-east monsoon. Nowhere on the plateau is the rainfall less than 40 inches per annum.

Population.—The Nilgiris district is the most sparsely populated district in the Presidency. Apart from the immigrants in recent times, following the British occupation of the tract, the Nilgiri plateau is the special home of three communities,—the Todas (exclusively confined to these hills), the Badagas and the Kotas.

The Todas are a purely pastoral people who live on the produce of their herds of huge buffaloes and gifts of grain from the other tribes. They do not practise agriculture in any form. They claim to be the original inhabitants of the hills and lords of the soil and live in lazy, Arcadian fashion in little scattered wagon-roofed huts, always most picturesquely situated. The earliest mention of the name Toda occurs in a record of 1117 A.D. The main homeland of the Todas is the country west of Ootacamund, but an isolated colony of them is to be found at Kodanad near the eastern edge of the plateau. Toda buffaloes graze on the Wenlock Downs during the greater part of the year, but migrate to the Kundahs and the more remote downs from February to May. Burning the grass is an immemorial custom of the Todas which has been officially recognised and

is now being officially regulated. Toda buffaloes number about 3,000.

The Badagas of the plateau are the descendants of Canarese who immigrated to it centuries ago from the Mysore country to the north. When this migration took place there is little to show. It must have occurred after the foundation of the Lingayat creed in the latter half of the twelfth century, as many of the Badagas are Lingayats by faith, and sometime before the end of the sixteenth century, since in 1602 certain Catholic priests from the West Coast who visited the plateau found them settled in the south of the plateau and observing much the same relations with the Todas as subsist to this day. They are the agriculturists of the hills and occupy the whole of the eastern half of the plateau except the tract around Kodanad. As already mentioned, the Badagas cleared vast areas of forest for the sake of shifting cultivation. The Badagas keep cows and buffaloes and supplement their agricultural income by the sale of milk and milk products.

The Kotas are the musicians and artisans of the hills. Their reactions on the vegetation are negligible.

DESCRIPTION OF THE VEGETATION

The natural vegetation of the Nilgiri plateau consists typically of vast stretches of grassland interrupted by numerous, isolated, compact, sharply defined and usually small woods composed of stunted evergreen trees. These woods are locally known as sholas, a term etymologically applicable to evergreen forests in general, but is best reserved for the stunted, high elevation evergreen communities occurring on the Nilgiri, Anamalai, Palni and other hill ranges of South India. The plateau vegetation consists roughly of 80 per cent. of grassland and 20 per cent. of shola forest. On the eastern half of the plateau or, generally, within the zone of the north-east monsoon, the proportion of shola to grass is considerably higher than is indicated by the above percentages. On the western half (and in the neighbourhood of Kodanad in the extreme east), the reverse is the case; grass is universal and the patches of shola are small and sparsely distributed. But all over the plateau the vegetational type is the same, a mixture of shola (with its seral stages) and grassland in proportions varying according to topography and in apparent ecological equilibrium.

Floristic composition of the sholas.—The species composing the sholas are all evergreen, and the tints of their foliage during certain seasons are of great beauty. The families most represented by tree species are Myrtaceae, Styraceae and Lauraceae. The undergrowth consists largely of Rubiaceous plants and of *Strobilanthes* (Acanthaceae). Fyson distinguishes 19 species of *Strobilanthes* occurring on the Nilgiris. The ground flora consists of a great wealth of ferns and mosses. One species of reed bamboo, *Arundinaria wightiana*, occurs frequently in the sholas. The principal tree species met with are: —

Michelia nilagirica.
Hydnocarpus alpina.
Pittosporum nilghirense.
Ternstroemia Japonica.
Eurya Japonica.
Gordonia obtusa.
Elaecarpus munrolii.
Evodia roxburghiana.
Mappia tomentosa.
Ilex wightiana.
Euonymos indicus.
Microtropis spp.
Turpinia nepalensis.
Meliosma spp.
Photinia spp.
Eugenia arnottiana.
Eugenia calophyllifolia.
Eugenia montana.
Casaeria esculenta.
Schefflera spp.
Viburnum spp.
Lasianthus venulosus.
Vaccinium nilgherrense.
Vaccinium leschenaultii.
Rhododendron nilagirica.
Maesa indica.
Rapanea spp.
Symplocos spicata.
Symplocos foliosa.
Ligustrum spp.
Cinnamomum spp.
Litsaea spp.
Neolitsaea zeylanica.
Glochidion spp.
Daphniphyllum glaucescens.
Macaranga indica.
Celtis tetrandra.
Garcinia gambogia.

The undergrowth consists of the following species: —

Berberis tinctoria.
Hypericum mysorense.
Rubus spp.
Dodonaea viscosa.
Rhodomyrtus tomentosa.
Osbeckia wightiana.
Wendlandia notoniana.
Hedyotis stylosa.
Ixora notoniana.
Psychotria spp.
Plectronia neilgherrensis.
Pavetta breviflora
Gaultheria fragrantissima.
Strobilanthes spp.
Lasiosiphon eriocephalus.
Elaegnus kologa.
Osyris arborea.
Atylosia spp.
Eupatorium glandulosum (an invasive exotic).
Mahonia leschenaultii.

It is convenient to speak of sholas as an ecological unit, but their floristic composition, their size, the height growth of their

trees all vary according to the altitude and according to whether the sholas occur in the eastern or western half of the plateau. *Hydnocarpus alpina*—a gregarious species—is, for instance, confined to the eastern plateau; a notable forest of this species is found on the slopes of Hulikal Drug. *Eurya* and *Vaccinium* are much more common in the western plateau. Similarly *Mahonia* which is an underwood species is practically confined to the western plateau. Certain species such as *Turpinia, Symplocos, Eugenia arnottiana* and *Rhododendron* are universally distributed. The stunted growth of the trees is a feature of high elevation shola. With decreasing altitude the height growth gradually improves till on the outer slopes at Coonoor and Naduvattam at the level of 5,000 to 5,500 feet, the shola is definitely of the high forest type and merges insensibly into the tropical evergreen forest which borders it below.

Factors governing the distribution of sholas.—Shola patches occur as a rule at the heads of streams in the folds of converging slopes, in wrinkles, hollows, concave declivities and depressions caused by landslips on the slopes of hills. They are thus usually confined to sites where the drainage of adjacent slopes converges or where the conformation of the ground is such as to attract moisture from the surrounding area. The presence of an adequate amount of soil moisture would appear to be an essential condition for the growth of shola, especially in regions where general ground frosts occur, as in the western plateau. Where frost is not a factor to be contended against, the shola is less fastidious about soil moisture. Sholas are, however, not to be found at the bottoms of valleys or on flat country where the movement of soil water is sluggish or where swampy conditions exist. Good drainage is as important as a sufficiency of soil moisture. Where the shola occupies the whole of an extensive slope within the frost zone, as is sometimes the case, it is probable that the original nucleii were the folds and hollows on the slope, from which points of vantage the shola crept outwards gradually colonising new territory. In view of the known fastidiousness of the shola as regards soil moisture, the study of the process by which it invades portions of slopes where there is an efflux instead of an influx of soil would be of great interest. A probable explanation is that under favourable conditions and within limits the shola is able to produce

for itself the edaphic conditions necessary for its extension. In a sense the shola practically makes its own soil—a dense layer of humus in varying stages of decomposition overlying a black soil of loose texture with a high proportion of organic matter and probably with a high hydrogen ion concentration. It must similarly have a marked reaction on the soil moisture, though this subject has not been studied yet. It is likely that the shola has the effect of increasing the soil water content in its immediate neighbourhood by holding up the water received by precipitation and by preventing too rapid run-off on the one hand and too rapid drainage on the other. By these means, given favourable conditions and freedom from disturbance, the shola is probably able to occupy positions which are topographically apparently unsuitable. The process must be a very slow one and the conditions necessary for its completion do not ordinarily occur, so that in practice the shola is by no means an invasive type of vegetation.

Within the habitat of the shola forest, the rainfall varies from 40 to 300 inches and the altitude from 5,000 to 8,500 feet. Provided that the temperature conditions are suitable and the soil moisture sufficient, the actual quantity of rainfall is not a determining factor. The composition of the shola is definitely dependent on both the rainfall and the altitude, but throughout its habitat the shola is remarkably uniform in its features as an organic vegetational community. Shola species are as a rule shallow-rooted; the profiles of new road cuttings made through shola forest near Naduvattam show that the root systems of the trees do not penetrate the soil to a depth of more than three feet or so, even where the soil itself is of considerably greater depth. Sholas are found growing on very shallow soil (often no more than a few inches deep) in broken country with numerous outcrops of bare rock. Nor does the shola appear to be fastidious as regards the chemical and mechanical composition of the soil; it grows freely on all the various kinds of soils occurring on the Nilgiris. In the matter of soil, as apart from its moisture content, the shola exhibits a very wide tolerance.

In spite of its being a shallow-rooted formation there are very few windfalls in shola forest. The folds and depressions in which

sholas naturally appear protect them to some extent from the violence of the monsoon winds. The stunted forms of the trees is probably an adaptation to resist damage by strong winds. That the poor height growth of the trees is not due to the soil and that there is nothing inimical in it to the free development of tree growth is evident from the magnificent specimens of *Eucalyptus globulus* growing on cleared shola sites. Some of these trees at Muthinad and Coonoor Peak are over 230 feet high and are among the tallest trees in India.

In the tract lying above what may be called the frost line, that is, over the western plateau generally, the shola patches are more numerous and of relatively larger size on western and northern aspects than on eastern and southern aspects. On the eastern plateau the effect of aspect is much less evident, because, as already stated, not only is the average elevation of the plateau about 1,000 feet lower, and the liability to frost consequently much less, but the occurrence of winter rains and the presence of cloudy skies serve to rule out frost as a general phenomenon. When frost does occur, it is usually purely local. The Kodanad area in the extreme east, which resembles the western plateau in topography and floristic appearance, is probably a localised frost zone. The influence of aspect on the distribution of sholas is in reality a temperature effect. Eastern slopes are cooler than western slopes, so that not only is the incidence and intensity of frost greater on eastern slopes, but the damage due to frost is also greater as such slopes are exposed to the morning sun which is known to intensify frost damage. This subject will be reverted to in a later paragraph.

Evergreen subseres on cleared shola sites.—Over the whole of Coonoor range (eastern plateau) and in certain parts of Ootacamund range (western plateau), such as the slopes north of Doddabeta, great stretches of country are occupied neither by shola nor by grass but by a kind of evergreen scrub, an associes of herbaceous, shrubby and arborescent evergreen species. The species composing this evergreen scrub are: *Rhodomyrtus tomentosa, Dodonaea viscosa, Wendlandia notoniana, Berberis tinctoria, Hypericum mysorense, bracken, Mahonia leschenaultii, Gaultheria fragrantissima, Rubus* spp., and

Strobilanthes spp. Stray trees of *Rhododendron* and its regeneration are also found. Careful examination of the scrubby growth often shows the presence of seedlings or specimens of *Eugenia arnottiana, Daphniphyllum glaucescens, Rapanea* and more rarely of *Symplocos* and *Turpinia.* Various stages of development can be observed in the structure and composition of the evergreen associes from purely herbaceous stretches of bracken and *Hypericum* through mixed forms to groups with a fair proportion of *Rhododendron, Eugenia, Daphniphyllum* and other shola species. Evergreen scrub is clearly an unstable and transitory community and marks stages in the succession to the shola climax. Mr. Cox observed that bracken is among the first species to colonise sites of cleared or burnt out shola and regarded that species as an indicator that a shola had previously existed on the site and had disappeared through felling or fire. A study of the various types of evergreen scrub met with indicates that in the majority of cases it is a subsere (secondary seral succession) taking place in localities previously occupied by shola forest. The fact that the evergreen scrub is most commonly found in typically Badaga country and in the neighbourhood of Badaga villages where large areas of shola were denuded by the Badagas lends support to this view. The secondary growth of shola species in *Eucalyptus* plantations made on cleared shola sites is a familiar phenomenon on the Nilgiris. It would seem therefore that the normal successor to a cleared or burnt out shola is evergreen scrub and that the site of a shola tends to reproduce a forest climax. The view that the destruction of shola is invariably or even usually followed by the intrusion of grasses does not appear to be supported by the writer's observations. The conversion of shola areas into grassland probably requires the permanent degradation of the soil factors by repeated burning or other similar causes.

The grasslands; floristic composition.—All over the plateau the ground not occupied by shola or by evergreen scrub is covered with a complex of grasses. (Lands under crop, forest or agricultural, are excluded, of course). The dominance of grassland over forest is strikingly seen in the Wenlock Downs and in the Kundahs, where the country is a vast expanse of grass interspersed with small, isolated, sharply defined shola patches. On the Wenlock Downs which is

the principal homeland of the Todas and is heavily grazed over, the grass is kept low and is only a few inches high. But in the Kundahs where the grazing is relatively light and lasts for only a few months each year, the grass is much taller and in places which have escaped burning for several years is as much as two feet high. Grass fires are uncommon on the Wenlock Downs. The following are among the species composing the grass complex: *Andropogon pertusus, Ischaemum pilosum, Themeda imberbis, Cymbopogon polyneuros,* and *Eragrostis nigra.* In swampy ground the composition of the grass is different. *Orchis mascula*(?) (*Sala misri*) occurs in small societies in Bison Swamp and in the valleys of the Billithadahalla and the Mukurti.

Factors governing the occurrence of grasslands.—Like the shola, the grass flourishes under widely varying conditions of rainfall and soil. In the Kundahs where the rainfall is generally over 100 inches and is in some places over 200 inches, the grass is able to hold its own against the forest. There are indeed no signs in this bleak region of the forest encroaching on the grassland. The Kundahs constitute the principal catchment area of the two great river systems of the Nilgiris, the Bhavani and the Moyar. Yet in this tract the extent of shola is negligible as compared with that of the grassland. The absence of fringing forest along the perennial watercourses and rivers on the western plateau is a remarkable feature of the Nilgiris vegetation. The principal habitat of the grass is the western plateau and in this region the grass is complementary to the shola, occupying residual land where the shola is unable to grow. The grass is dominant on easterly and southerly slopes.

Invasive plants on grasslands.—Three species of plants, all of them exotics, namely, *Eupatorium glandulosum, Ulex europeus* (gorse) and *Cytisus scoparius* (yellow broom) have made considerable inroads into the grasslands in recent years. *Eupatorium glandulosum* is a Mexican species and is an escape from gardens into which it was introduced early in this century. It readily takes possession of areas where the soil is even temporarily exposed. It comes up on the cuttings made for hunt rides in the Wenlock Downs and in places where the hooves of Toda buffaloes have wounded the soil.

It occupies areas gregariously in unsightly colonies, is apparently not easy to eradicate and bids fair in course of time to ruin the beauty of the downs. Gorse was introduced on the plateau many years ago as an ornamental plant. It has since spread over considerable areas, especially on the slopes falling to Parson's valley and in the neighbourhood of Nanjanad. Its yellow flowers make a show all the year round, but there is little otherwise to recommend it and it is certainly not to be preferred to the grass which it is steadily displacing. Broom is much less invasive than the other two species mentioned above. It was apparently introduced on the downs by the Forest Department in an effort to afforest the grasslands. It has established itself and colonised small areas at the head of the bridle path to Bangi Tapal. It is also to be found on the slopes near Nanjanad along the road to Avalanche.

Rhododendron trees in grasslands.—Scattered *Rhododendron* trees, sometimes in clumps but generally isolated, are often seen on grassy slopes. In the vicinity of these trees and on road cuttings and ground where the soil has been exposed, natural regeneration of the species is frequently met with. *Rhododendron* is fire-hardy and is apparently not destroyed by the annual grass fires which are common in this tract. It has been suggested that the scattered *Rhododendron* trees are the vestiges of sholas which were destroyed by fire in the past. This may be so in certain cases where the nature of the country and other conditions lead us to expect to find shola but where no shola exists now. But generally speaking the presence of trees of this species would appear to indicate the contrary probability, namely, that they are pioneers rather than vestiges. The presence of regeneration in various stages lends support to this view. Moreover, *Rhododendron* is not a common species in mature sholas. It is a strong light demander and cannot regenerate itself under the dense cover of the shola forest. Where this species occurs in shola it is usually confined to the periphery. It appears to be an early species in the shola succession, tending to disappear with the mature development of the shola.

Shola as forest climax.—The vegetation of the Nilgiri plateau rests on mature soils in the formation of which pedogenic processes have had full play and are no longer actively operative. The vegetation may therefore be regarded as being in equilibrium with the

edaphic and climatic factors, except indeed in the cases where subseres can be clearly traced. A study of the altitudinal zonation of the forests on the outer slopes of the Nilgiris shows that both on the eastern and western slopes the progression with increasing altitude is towards an evergreen climax. Ecologically therefore the shola—the only closed forest type to be found on the Nilgiri plateau—is the upward projection by gradual stages of the tropical evergreen forest which borders it at lower elevations. The shola is clearly the forest climax of the plateau. There are signs, however, that the evergreen forest has overstepped its optimum habitat and entered upon a region where one or more factors contrive to keep it in a state of stagnation, defence or retreat. Of invasion of new territory by the shola there are very few signs. In an altitudinal range of 3,500 feet (from 5,000 to 8,500 feet above sea level) the forest climax remains the same, showing no signs of zonation. In the higher altitudes of its habitat, the size of the shola is reduced, it becomes fastidious about soil moisture and its hold on the ground, generally speaking, is feebler. The hygrophilous evergreen forest here encounters conditions to which it is unable to adapt itself. Whether a limit would be reached for the growth of the evergreen forest if the Nilgiri plateau extended to still higher altitudes, and, in that event, what vegetational community would occupy the ground must remain matters for speculation. The writer's opinion is that such a limit would probably be reached sooner or later and that the defeated forest would give place to a grassland climax. It seems unlikely that conifers would make their appearance at all at any elevation.

Grassland as climax in the frost zone.—The preponderance of grassland over tree growth on the Wenlock Downs and in the Kundahs has been mentioned. In this region the integrity of the grass cover is often unbroken by woody growth over extensive areas and the grass is so evidently at home in this habitat that, apart altogether from rational considerations, it is difficult to resist the conclusion that the grassland is the climatic climax over at least the greater part of the territory which it occupies at present. It is probable that the aggregate extent of shola forest on the western plateau was appreciably greater a hundred years ago than it is now. Considerable destruction of sholas took place in the early days of the settlements on the Nilgiris. A high percentage of these cleared shola sites has, however,

been since absorbed in bluegum, *Acacia,* tea and other plantations. But the earliest pictures of the surroundings of Ootacamund generally depict treeless hillsides and small woods confined to the folds of the hills. (A number of these pictures can be seen in the Nilgiri Library.) The floristic appearance of the downs appears to have been much the same as it is now even in the earliest times of which we have any reliable account. The pastoral Todas have been on the Nilgiris for many centuries—the date of their advent is unknown—and the grass has clearly existed on the Nilgiris for at least as long as the Todas have. A plant community which has been in possession of its territory for centuries is entitled to be called a stable association, whatever the factors that ensure its stability might be.

Over the whole of the grasslands the rainfall is such as is commonly associated with a forest climate. In the Kundahs, where the grass is dominant, the rainfall is well over 100 inches. In general the vegetational climax in localities where the rainfall exceeds 100 inches is a forest formation. Clearings by man, fire, grazing or, briefly, the biotic factor, may degrade the forest climax, may give permanence to a forest sub-climax, may alter the type of the forest, but cannot, in view of the rainfall, admit and stabilise an altogether different formation such as grassland unless there is a natural factor operating to give the grass an advantage over the native tree growth. The fact that the grasslands are mainly confined to the Toda country and the fact that the Todas graze their buffaloes in these areas and burn the grass regularly are suggestive of a connection between the Todas and the occurrence of grasslands. A small community of Todas exists on the Kodanad grasslands on the eastern edge of the plateau, although this area is cut off from Todanad by miles of Badaga country. These facts might be cited in support of the view that the grass is secondary and has succeeded to a previously existing forest which was destroyed by persistent grazing and burning. But heavy grazing and regular burning are not peculiar to the Nilgiri plateau, and their effect on the vegetation is not to convert a forest into open (and generally treeless) grassland in other tracts. On the North Coimbatore plateau, for instance, where the forest is burnt regularly and the incidence of grazing far heavier than that of Toda grazing on the Nilgiris, and where, moreover, the average rainfall is considerably less, the forest has become undoubtedly degraded and open, but shows no signs of

disappearing. Grasslands occur at similar elevations on the Palnis and the Anamalais where no Todas live. In the eastern half of the plateau where much direct damage was done to the sholas by the Badagas who made extensive clearings in the forests and burnt the areas in the interests of agriculture and pasture, grass is much less prevalent than in the western half and evergreen species are reasserting themselves on the cleared shola sites. The Todas are not axe-men, do not practise agriculture and do not clear forests. There is no reason to suppose that their habits and mode of living were ever other than they are now. It is indeed far more likely that their pastoral mode of life was evolved by the environment in which they found themselves, rather than that they created a suitable environment for a deliberately selected mode of living, even assuming that it was possible for them through the means at their disposal to bring about such a change in the vegetational cover. The character and temperament of the Todas as well as the available historical evidence contradict the latter supposition. The fact that they are exclusively confined to the grassy tracts simply suggests that they were entirely dependent on a previously existing environment and had no need to penetrate the forests on the eastern plateau.

It is therefore overwhelmingly improbable that the grasslands (or even any considerable area of them) are secondary to a previously existing forest climax. If this view is correct, the grasslands must be regarded as a climatic climax of the Nilgiri plateau.

Dual climax of plateau vegetation.—If what has been said above is correct, we are forced to recognise two fundamentally different types of vegetation, evergreen shola forest and grassland, as independent climaxes in ecological equilibrium, whose relative distribution is topographically determined. The occurrence of two climatic climaxes within the same climate is an unusual phenomenon which it seems difficult to fit into Clement's system of ecology.

Theory of frost as master factor in shola-grassland distribution.—While grazing and burning are admittedly factors tending to limit tree growth and favour grass, it seems clear that a natural factor is at work which primarily governs the relative distribution of shola and grassland. It has already been suggested that this factor is frost. Frost is, however, not necessarily inimical to the formation

of a forest climax; the manner in which it limits the spread of shola remains to be considered.

The peculiarity of the climate of the Nilgiri plateau, which combines a high intensity of solar radiation, a great range of daily temperatures and winter ground frosts with a rainfall varying from adequate to torrential, has already been referred to. The conditions of rainfall, humidity, insolation and altitudinal zonation are such as to develop an evergreen type of forest on the plateau. But the occurrence of general frost over wide areas is an adverse factor. Frost is presumably particularly injurious to the indigenous evergreen species, because these species do not shed their leaves and do not go through a period of rest during the frosty season, in the manner in which broad-leaved species—their analogues—do during winter in the temperate zone, but are throughout the year in a state of greater or less activity induced by the favourable moisture and sunshine conditions. Frost is, again, particularly destructive on the Nilgiris, because a frosty night is followed by a bright tropical sun spurring the leaves to great photosynthetic activity. In Europe, as also in Northern India, where the winter cold is due to latitude and not merely to altitude, although the frost is much more severe, the damage caused is less because it is followed by a weak winter sun and because, of course, the flora is that proper to (and adapted to) a temperate region. Being both evergreen and hygrophilous, the shola is especially frost tender. It is able to *grow* under frosty conditions when once established, but shola species are unable to reproduce themselves freely and invade new ground where frost occurs.

The precise manner in which frost causes injury to plants is apparently still not well understood. On the Nilgiris, frost damage is confined to seedlings and young, unestablished plants. Established trees and saplings of shola species suffer no injury even in relatively heavy frost. In temperate climates frost causes the withdrawal of water from the cells and the formation of ice crystals in the intercellular spaces. If the subsequent thaw is slow, the water is able to return to the cells and no injury results. Exposure to the morning sun causes rapid thawing of the frozen water which is then unable to resume its place in the cells. Why the rate of thawing should affect the ability of the cells to reabsorb the water is apparently not known. This explanation applies to plants in the temperate

zone, where frost is generally severe and temperatures much below zero are reached and where the vegetation is dormant during winter, its water requirements being reduced to a minimum. It is doubtful, however, whether this explanation will apply to the destructive effect of frost on the Nilgiris. Frost on the Nilgiris is rarely severe enough to freeze the cell contents of plants. Secondly, the vegetation is not in a dormant condition during the frosty season and continues to make heavy demands on the soil for water. If the injury is due to the freezing out of water in the cells of the leaves, it should be apparent in the tender leaves of established trees and plants also, at least in the cases where such leaves happen to be very near the ground level. This, however, is not the case. It seems probable that on the Nilgiris frost damage is in reality a wilting effect, due to water shortage. No figures are available of ground temperatures during frost on the plateau. The temperature of the air about four feet from ground level sinks as low as 28°F. There can be no doubt that the temperature of the superficial layers of the soil must be several degrees lower, and is probably sufficient to freeze the soil water to a depth of five or six inches. Frost damage is then probably due to the plant being unable to draw water from the frozen soil to make good the transpiration losses of the leaves which begin active work when exposed to the morning sun. On this view frost damage would be confined to plants whose root systems were within the frozen layer. This is actually the case. Older plants and trees with root systems tapping deeper layers of the soil where the water is not frozen are unaffected by frost. The fact that tender coppice shoots of blue gum are not destroyed by frost while seedlings of the same species are often killed appears to support the view that the injury is due to water shortage. Further support is lent to this theory by the fact that one of the methods by which potato growers on the plateau save their crops after frost has occurred is to water the plants very early in the morning.

Within the frost zone therefore the shola thrives in areas protected from the morning sun, that is, on western and northern slopes, other conditions being suitable. It occupies sites where the danger of wilting as an effect of frost is neutralised by the abundance of moving soil water. For the same reason, the shola tends to advance in the directions in which it casts its morning shade. The grass is

equally destroyed by the frost, but possessing, as it does, a perennial rootstock and being able to spread vegetatively, it revives quickly and resumes possession of the ground when the season of frosts is over.

(NOTE.—This paper was submitted to the Indian Science Congress, 1937 session.—ED.)

NOTE ON SANDAL REGENERATION

By J. E. M. Mitchell, Chief Forest Officer, Coorg

The sandal tree has been so well described in Troup's "Silviculture of Indian Trees" that it is unnecessary for the writer to elaborate on this.

Localities and where sandal is found growing in large quantities

Sandal is generally found growing between 2,000 to 4,000 feet elevation, but is also found at sea-level. It is found growing profusely in Coorg, Mysore and in the Nilgiri, Coimbatore, Salem and Arcot districts of the Madras Presidency. It is also found in one or two districts of the Bombay Presidency.

Types of forests

Sandal is not usually found in dense high forests, but it occurs chiefly in open scrub forests, hedge rows, lantana bushes and in bamboo clumps. The tree also grows on banks of perennial streams.

It is usually found on rocky and gravelly soils. In open scrub forests, sandal is often found growing in groups. It is also found in shola forests of the Salem and Nilgiri districts, where the rainfall varies from 40″—50″. In Coorg it attains its maximum development in the semi-evergreen forests and individual trees of 4 feet girth and over with a height of 70 feet are to be found in such forests. Being also much less susceptible to spike and fire, the artificial regeneration of sandal in Coorg should be confined to such forests.

Rainfall

The rainfall in the larger sandal tracts varies from 30″—65″, although cases are known where it has been found in areas of higher rainfall.

Species with which sandal is associated

A wide variety of species is acceptable to sandal as its host, but the following are perhaps particularly suitable:

Tectona grandis, Pterocarpus marsupium, Lagerstrœmea lanceolata, Terminalia tomentosa, Anogeissus latifolia, Strychnox nux vomica, Pongamia glabra, Cassia siamea, Cassia fistula, Albizzia amara, Albizzia lebbek, Albizzia odoratissima, Erythrina lithosperma, Acacia leucophlœa, Acacia suma (not in spike areas), *Dendrocalamus strictus.*

Its important characteristics

For its proper development, the sandal tree depends upon the host trees; it is, in fact, an obligate root parasite. It has a deep spreading root system, sending its roots long distances, even up to 100 feet in search of its host.

Reservation of sandal

Troup points out that earlier forest reservations were carried out in types of forest containing teak and other timber-bearing trees where sandal did not occur. In this way sandal tracts largely escaped reservation and the area of sandal in Government forests, which must be relied upon for future permanent supplies, is not so great as it might have been and the natural sandal-bearing area has been much restricted. This is certainly the situation in Coorg at the present time, only about 2 per cent. of the growing stock being in the Reserved Forests. In Madras, on the other hand, the Forest Department long ago realised the great value of sandal and sandal-bearing areas were constituted "Reserved Forests" and brought under Working Plans. In Coorg, there are possibly several reasons why such tracts were not reserved: (1) Sandal is a royal tree and can only be disposed of through Government agency; (2) the invasion of lantana and its rapid spread in some of the sandal tracts led previous forest officers to believe it was not worth while constituting such areas as Reserved Forests; and (3) the outbreak of spike and its subsequent spread caused considerable doubts if it was worth while attending to these areas further.

Sandal policy in Coorg

Proposals from 1900 onwards have been made to bring the sandalwood areas under a working plan or scheme, but it was not till 1929 that a temporary working scheme was introduced. Under

this scheme, dead trees only were to be extracted. As, however, the actual yield of dead trees has proved to be much below the estimated yield, this scheme is now being replaced by a new working plan.

Increasing sandal-growing stock in Coorg

Due to spike and spread of lantana in *Paisaries* (Unreserves) it was thought advisable to try by all means possible to increase the growing stock in Reserved Forests and attempts since 1878 have been made to raise sandal plantations. Until recently the method employed was to clear-fell an area, leaving about 10—15 standards per acre as hosts, to sow sandal at various espacements* along with *dhall*. An inspection of the older plantations showed that many soft-wooded species have come in and suppressed the sandal. The only sandal trees, which are fairly well developed, are those found growing on the main inspection paths and on the edges of plantations which have escaped suppression. The difference between the development of the trees on the margins of these plantations is furnished in the statement affixed to this note. When the writer inspected a number of these plantations in 1934 and saw their poor condition and also bearing in mind the fact that no revenue from sandal had been obtained, he came to the conclusion that the further extension of such plantations was not profitable. On the advice of the Central Silviculturist he decided to concentrate on the more recent plantations (1929—1934) in order to see whether by regular tending and thinning such plantations could be established successfully at an economic cost.

To-day in 1938, with the further knowledge at his disposal, the writer is of the opinion that sandal can be raised in plantations successfully and at a profit. The area of the Gangwara plantations, for example, of 250 acres, has, in the last two years, yielded 35 tons of heartwood, which is equivalent to a revenue of Rs. 110 per acre. Other plantations, *e.g.*, Kargodu, Malambi and Kattapura also are beginning to show handsome returns. It is quite certain that these plantations would have given even larger profits, if they had been tended and thinned regularly.

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* The following espacements were tried: (1) 6′×6′; (2) 12′ × 12′; (3) 18′ × 12′.

Also another factor that has led him to modify his opinion is that the rate of growth of sandal in plantations, adequately thinned and tended in the last 5 years, shows that the current annual increment has been raised from 0.3″ to over 1″. If these plantations are properly tended and thinned, he sees no reason why handsome returns cannot be relied on and on a much reduced rotation. The 1914 plantation at Malambi already shows a net profit of Rs. 34 per acre and there is still the main yield to come.

He would not, however, advocate forming sandal plantations in deciduous forests, but would confine them to the semi-evergreen forests. Two methods of formation are recommended:

(1) Clear-fell and leave as hosts about 20 standards per acre—burn in February, after the year of the felling.

(2) Sow sandal seeds (after removing the pulp) in May at an espacement of 12′ × 12′ and at a distance of about 3 feet from the sandal. Sow one or two seeds of *Cassia siamea*.

(3) Two weedings in 1st year and possibly two in 2nd year.

(4) Tendings when required, possibly 4th or 5th year.

(5) Thinning about 5th year leaving no two sandal nearer than 20 feet of each other.

Second method.—Instead of clear-felling, cut lines 12 feet wide at intervals of 50 feet. Heap and burn slash on the lines and in May sow sandal at 12 feet intervals on the lines. Weed and tend as above. The objection to this method is that game are often attracted to such strips and it is not, therefore, recommended where game is at all plentiful.

It is very important to secure early germination and experiments have shown that the period of germination can be reduced from six weeks to 20 days by pre-seed treatment. The importance of this is that so often in the past late germination has led to the subsequent failure of the young plants not having established themselves before the onset of the dry weather. Another danger to guard against is the destruction of the seed and the young seedlings by rodents. Recently to overcome this difficulty, plants have been

raised in nurseries free from rodents and one year old stumps have been planted out with success. If natural transplants are available, they may be used with equal success.

Tireman, when he was Chief Forest Officer, Coorg, for a long period, apparently did not believe in clear-felling before planting, but his earliest attempts at forming a plantation met with more success than that of his predecessors. His method was to leave the upper canopy intact and to remove the undergrowth and to open up the middle storey, leaving such bushes as were required as intermediate hosts. In Meenkolli and Anekad Reserves, the selecected areas of 40 acres, cleared the undergrowth and dibbled seed at an espacement of $6' \times 6'$. Out of each of these 40-acre coupes, he has succeeded in establishing sandal over about 10 per cent. of the area. It is most noticeable that such successful areas are confined to strips of 3-4 chains wide near the road margins. The tallest sandal in the 1917 area are 30 feet and girth 2 feet. The principal species in these areas are teak, *Anogeissus, Pterocarpus marsupium, Terminalia tomentosa, Kydia calycina, Lagerstrœmea lanceolata* and *Dendrocalamus strictus.* It is seen from a perusal of the records that Tireman thought the same result could be achieved by sowing the seed under bushes. He made attempts to do this but did not achieve much success. By dibbling sandal seed under bushes he complained of the frequent attacks by rats and also the suppression of the sandal seedlings by weeds.

The original method of clear-felling, burning and sowing sandal with *dhall* was then reverted to, although Tireman had recorded that sandal grown in this way looked extremely promising for the first 12 years or so, and then suddenly fell away for no apparent reason, *in spite of tending.* A number of factors may account for this phenomenon, perhaps, the lack of suitable permanent hosts, the area having been first clear-felled and burnt, or again, the failure to thin out the sandal plants in early youth, the result being that they become parasitic on each other. Robinson in 1929 tried an experiment of keeping the middle-sized trees as hosts and clearing the undergrowth and then sowing sandal at an espacement of $6' \times 6'$. When the writer last saw this plantation in May 1937, it certainly looked promising and he was much more impressed with this method than the clear-felling, burning and kumring the sandal with *dhall.*

Unfortunately, it was formed in a deciduous type of forest and has been subjected to three attacks of spike, which have since been brought under control. The original method was then reverted to, but *Cassia siamea* was, at the same time, introduced to act as host. In many cases, the *Cassia* was sown densely and had to be thinned out. In other cases *Erythrina indica* and *Lithosperma* were introduced as hosts but deer were attracted to such plantations and the sandal has been badly damaged. In 1932 and 1933 it was decided to leave 10—15 trees per acre and to sow sandal 12′ × 12′, *Cassia siamea* being introduced as soon as the sandal seed had germinated and the young plants had begun to grow. In such areas large numbers of softwood species came up and had to be cut back to prevent them from suppressing the sandal. The results have been successful enough but it is all important to see that the young plants are kept free from overhead suppression of the regrowth of fast-growing softwood species. The writer ascribes the poor growth in so many of these plantations very largely to the failure to attend to this operation. As explained above a closer initial spacing of less than 12′ × 12′ is not recommended. Sandal cannot be compared to a teak plantation which, as a rule, can be left after the 3rd year till the 5th and 10th year when thinnings are done. Sandal is an obligate parasite and planting 6′ × 6′ means that in a short time many such plants become parasitic on each other and hence miserable specimens are to be seen after 50 years. They are merely the survival of the fittest.

Regeneration (Natural).

It is most noticeable that natural regeneration of sandal is seldom found in the plantations. This is not to be wondered at because the seed have little chance of germinating. Most of the plantations are in localities where the rainfall is from 60″—80″ and combined with the dense overhead shade caused most of the seed to rot.

The writer is of the opinion that (as most of the Reserves in Coorg contain very little natural sandal although just over the Mysore frontier sandal is plentiful) sandal is most exacting as to the soil and type of forest it will grow in. It cannot tolerate interference from other species which threaten it with overhead shade but prefers side shade.

Unreserves

The writer has inspected many such areas in Coorg and finds that in spite of lantana, spike and fires, much sandal still survives and is flourishing. Considering that it has generally to contend with damage by grazing and fires, it is perhaps surprising that in spite of the fears expressed in 1900 any sandal is left. It is estimated that in the better sandal-bearing unreserves, there are approximately some 2,700 tons in North Coorg district. To this may be added a further 800 tons in similar areas in South Coorg.

The details of 100 per cent. enumeration of such areas in North Coorg are given in the statement appended. It will be seen how well distributed the various girth classes are in spite of fires and grazing.

Spread of Sandal

Many forest officers have expressed their fears that, if the solution of spike disease was not found, sandal would soon become extinct. The writer has expressed this view himself when he was in Coimbatore district in 1925, yet sandal is still spreading. The writer is of the opinion that if suitable localities for sandal are not invaded by lantana or similar weeds, and if grazing is permitted, then the danger of sandal becoming extinct will not arise.

Policy in future

If there are localities where sandal grows naturally and such localities are at the disposal of Government, the writer believes that the prevention of sandal can be ensured by tending and encouraging its regeneration, both by natural and artificial means.

Tending of sandal

In early youth sandal requires plenty of side shade, but must have full overhead light. If the young sandal is to survive, it is essential that it makes haustorial connection as soon as possible and this can be done by sowing *Cassia siamea* near each plant. Tending in the first three years consists of removing any branches of other trees, which are interfering with its development. Sometimes subordinates have made the mistake of removing host trees. In Coorg (where sandal must not be cut) clearings made for cultivation have demonstrated only too well the damage done. After some time, the sandal begins to wilt and gradually dies off for want of hosts.

General notes on tending

For this purpose sandal can be classified into three stages. First, till the seedling attains 2 feet height; second, sapling stage from about 2 feet to 12 feet and third stage over 12 feet height.

In the first stage the young plants should not be exposed, as it may be killed by sun or browsed down. Suppression by grass and herbaceous growth must be guarded against the hot sun and such hosts as *Cassia siamea* serve this purpose very well. Seedlings under heavy shade are lanky and unhealthy and they need plenty of air. Where necessary the interfering growth should be cut back.

When the plant is fully established, that is, in the second stage, it is essential to see that it has plenty of overhead light and side shade. For this purpose it is essential to retain all small trees and shrubs which give side shade and remove branches of other trees which are interfering with the development of the crown. Climber-cutting is an important operation in all stages. After the sandal has reached about 12 feet it is essential to see that all surrounding weed growth in the neighbourhood of 3′-4′ be cut back, which might interfere with the circulation of air. From observations in the field, it is most noticeable that trees free from weeds and grass are better developed than those which are surrounded with obnoxious growth. In all tending operations, it must be remembered that the interfering growth may be acting as hosts and therefore they must only be cut back, but not uprooted or killed.

Later on in life, in addition to removing branches of other species interfering with the development of its growth, it is also essential to cut creepers. Inspections show that sandal trees, situated on the edges of the plantations and on main inspection paths, are extremely healthy and are about twice the girth of those growing between the inspection lines. The better development is probably due to the following:

(*i*) Inspection paths* are kept constantly free of overhead growth and also weeds, grasses, etc., and hence there is free circulation of air and plenty of overhead light.

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* Note—In dry deciduous forests probably cattle would be attracted to lines and in inspection paths and destroy the sandal.

(*ii*) Sandal on paths and edges are not so densely stocked as in other parts, having been regularly tended and thinned at intervals, also host trees in the vicinity are able to meet the demands of the sandal.

Spike

Up to date the cause of spike has not been discovered but there are indications that there are certain factors which help to increase its spread. These possibly are—

(1) In lantana areas or areas dominated by some such plant the incidence of spike is higher when compared with non-lantana areas.

(2) Areas too densely stocked with sandal

(3) Fires spread through sandal areas and sandal becomes weakened and susceptible to attack.

(4) Sandal not tended becomes suppressed and this helps to make the tree susceptible.

(5) Sandal being parasitic on certain group of host plants which make it susceptible to attack, *e.g., Acacia suma.*

Although McCarthy was the first to notice spike which started in Coorg, the present stock map indicates that the attack has not spread so rapidly in Coorg as it has in Madras. This might possibly be due to the fact that in the former most of the sandal is found in semi-evergreen forests.

In the past four years all dead and spiked trees have been removed. To-day only a few spiked trees are to be found in this zone. The writer is led to believe that if (*a*) rigid fire protection is adopted, (*b*) host plants known to be sandal spike resistant are grown in sandal areas, (*c*) girdling and killing with Atlas solution freshly attacked trees, (*d*) lopping and burning the diseased foliage as also that of all sandal trees within 100 feet of the attacked tree, the loss by spike can be very materially minimized.

Statement showing the difference between the development of sandal on margins of plantations to that situated inside in Meenkolli sandal area.

Sl. No.	Trees on the margin, average diameter.	Trees situated inside, average diameter.	REMARKS.
	Inches.	Inches.	
1	4.5	3.5	
2	4.6	4.5	
3	4.8	3.6	
4	5.8	3.1	
5	4.3	4.3	
6	6.0	6.0	
7	5.6	3.0	
8	5.8	3.1	
9	7.6	5.1	
10	4.8	4.5	
11	4.1	3.1	
12	3.6	4.9	
13	4.8	3.9	
14	3.9	2.3	
15	7.5	5.4	
16	7.3	5.4	
17	5.8	4.9	
18	12.0	4.7	
19	3.6	2.1	
20	8.6	3.5	
21	3.6	4.6	
22	2.8	4.7	
23	6.3	4.2	
24	7.2	3.8	
25	6.7	4.9	
26	7.5	4.0	
27	9.3	4.0	
28	5.6	4.8	
29	3.3	6.2	
30	2.7	3.2	
31	5.8	5.3	
32	7.3	5.2	
33	6.5	5.6	
34	6.4	6.3	
35	..	2.7	
36	..	3.2	
37	..	8.0	
	196.0	160.9	
	Average diameter 5.76	Average diameter 4.35	

Statement showing the number of trees in different girth classes in good sandal-bearing Unreserves of North Coorg.

Girth.		Somwarpet Range.	Fraserpet Range.
6″	...	20,600	5,475
9″	...	16,402	3,143
12″	...	14,003	1,853
15″	...	11,217	1,070
18″	...	8,431	672
21″	...	5,641	358
24″	...	3,439	196
27″	...	2,157	94
30″	..	1,068	42
33″	...	552	31
36″	...	322	14
39″	...	186	9
42″	...	84	13 above 39″
45″	...	80	...

TREATING FENCE POSTS BY MEANS OF OLD INNER TUBES

By H. Trotter, Utilization Officer, Forest Research Institute

Abstract.—Describes a cheap and simple method of treating green fence posts and other round green timber with water solution preservatives, by using pieces of old motor car inner tubes attached to one end of the posts. The method described is a simple modification of the well-known Boucherie process, and is well suited for fencing operations in the forest.

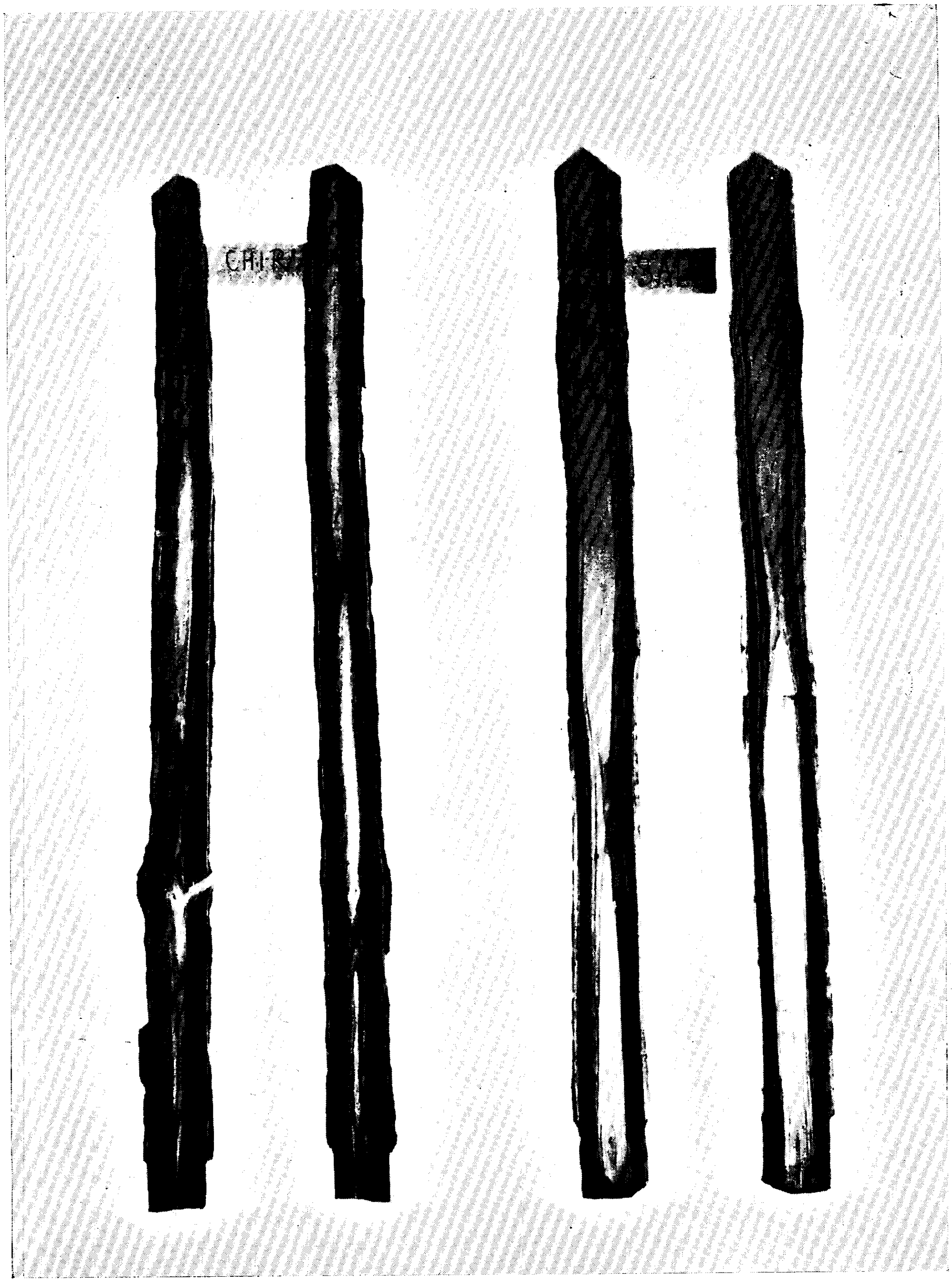
Recently Messrs. Hunt and Wirka, of the Forest Products Laboratory, Madison, U.S.A., described a simple but ingenious

method of obtaining thorough penetration in the sapwood of fence posts by using old inner motor tubes and a cold water solution preservative.

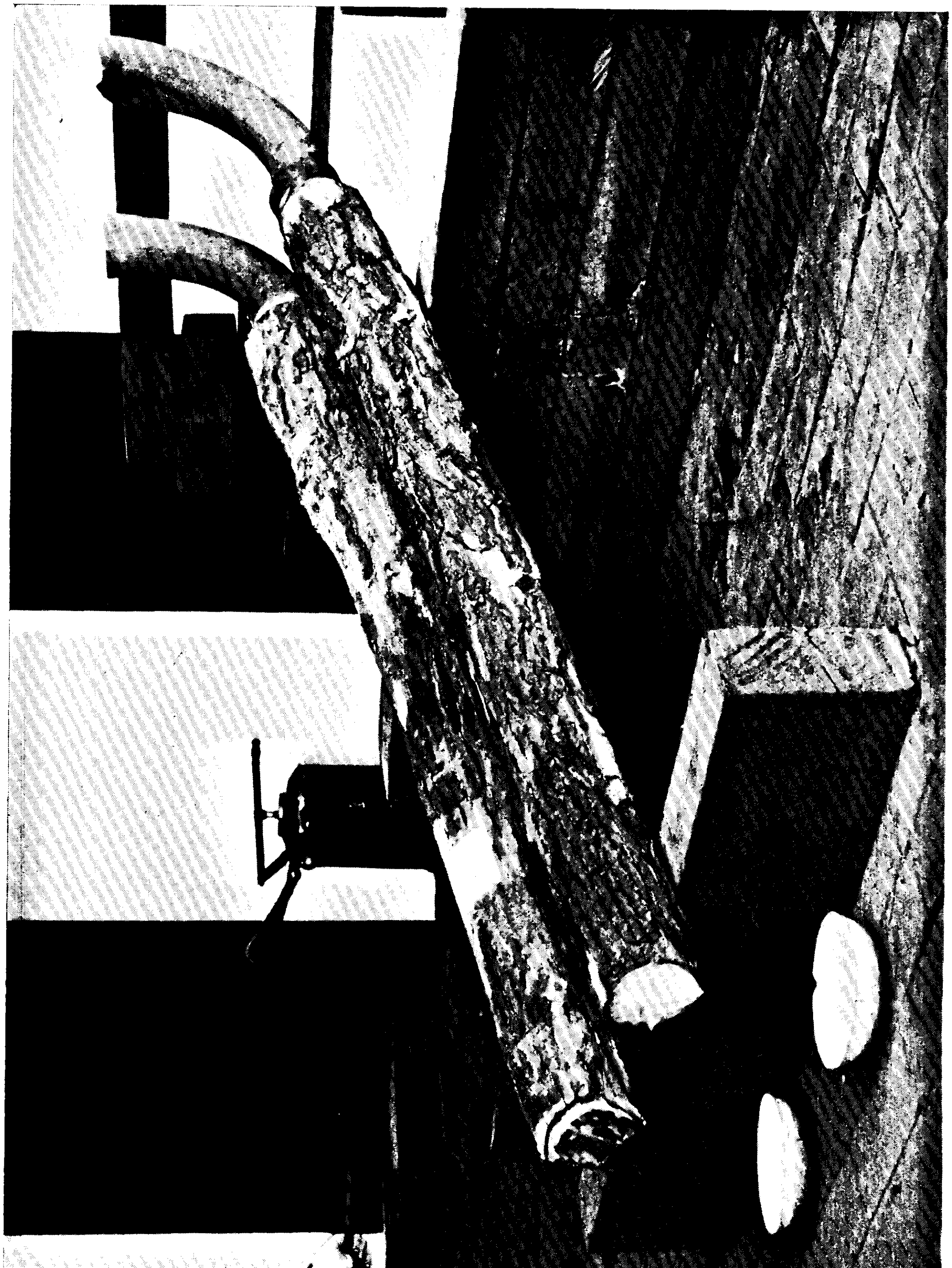
As the method is very simple and very cheap, the writer tried it in a small way on some Indian woods, and the results of the investigation, few though they are, are given below for the benefit of those who would like to try the treatment. The process is really a modification of the old Boucherie process used in France and Germany. In the first place the posts to be treated must be absolutely green and with the bark on. A small portion of the bark is peeled off for a distance of about 4 to 6 inches at the large end of the post, and care should be taken to see that the bared portion is quite clean and smooth. A section of old inner tube, about 2 feet or 2 feet 6 inches long, is then forced over the peeled portion, and tied round with a piece of wire, string, or strip of rubber. The post is then laid on a rack or other support, so that the large end (with the piece of tube attached) is about 2 feet or so above the lower small end. The loose end of the piece of tube is then fastened to a frame slightly above the top of the post by means of a nail or drawing pin. The photograph opposite will at once demonstrate the idea. The preservative (Ascu was used in the Dehra Dun experiments) is then poured into the open end of the tube. In a short time, if the post is green and full of sap, the sap will start dripping out at the bottom of the post, and the preservative in the tube will slowly flow into the post to take its place. Eventually the preservative itself will start emerging at the bottom end of the post. This is an indication that the treatment is finished. The pole is then removed and dried.

The length of time required for the preservative to flow through a post varies with the species being treated, the thickness of the sapwood, and whether sap is plentiful or not.

The treatment was tried out at Dehra Dun on two saplings each of sal, chir and teak. The saplings were cut in May, and the posts were about 7 feet long. In the case of sal, the leaves were out and the posts were full of sap. In the case of teak, the trees were leafless, and there was very little sap in the wood. The chir saplings were in a green condition and were full of resin. The results obtain-



Photograph showing penetration obtained in chir and sal posts by using the inner tube method of treatment



Photograph illustrating the inner tube method of treatment on fence posts

ed with these three species were interesting, and are recorded beolw:

Table of results.

Timber.	Period which elapsed between cutting and treatment.	Weight of pole just before treatment, in lbs.	Weight of pole after treatment, in lbs.	Increase in weight, in lbs.	Amount of sap removed before Ascu solution came out, in lbs.	Total absorption of preservative—sum of 5 & 6, in lbs.	Time for sap to start flowing out.	Period for complete treatment.	Penetration (Remarks).
Sal ..	2 days	98·8	100·3	1·5	9·5	11·0	¾ hrs.	24 hrs.	Complete in sapwood.
,, ..	5 days*	98·9	102·2	3·3	5·0	8·3	¼ ,,	24 hrs.	,, ,,
Chir ..	2 days	Not weighed					½ ,,	6 ,,	Complete.
,, ..	5 days*	63·4	65·7	2·3	5	7·3	¼ ,,	6 ,,	,,
Teak ..	2 days	Not weighed			Nil	..	No sap but preservative emerged within a short period.		Erratic.
,, ..	5 days*	Not weighed			Nil	..	,,	,,	,, ,,

*Dried ends (about 6 inches) cut off before starting the experiment.

From the above table, it will be seen that complete penetration, even in the small heartwood, was obtained in the case of chir, while complete penetration of the sapwood was obtained with sal. In the teak posts, erratic penetration throughout the heartwood and sapwood was obtained. This was due no doubt to there being no rising sap in the wood, but the remarkable thing was that the preservative went straight through the teak posts within a matter of a few minutes. Penetration laterally was however erratic. This again was due no doubt to the lack of sap, and with a post cut after the leaves had flushed, complete penetration would no doubt be obtained.

It is interesting to note that in the case of sal, the sap started dripping within a comparatively short time, but it took 24 hours before full strength Ascu started to emerge, although Ascu mixed with sap had been emerging for some time previously.

In the case of chir, sap and resin started emerging quickly, and six hours later full strength Ascu started to come out. One important point was noticed during the experiment and that was that the ends of the posts must be absolutely fresh and damp if proper results are to be obtained. In the case of the posts which were kept five days before treatment, no Ascu would penetrate the upper end of the posts until a section of wood was cut off and a fresh end section exposed. Even in the two-day old posts it was found that better results were obtained by cutting off a small section at both ends of the posts before starting the treatment, so as to obtain a wet end section. It must be remembered that the experiment was done during very hot dry weather in May, and the ends of the posts dried very quickly. It was also found that a little grease was very helpful in stopping leakage under the rubber tube at the top of the posts. If the grease is spread thinly over the stripped portion at the top of the post, a completely waterproof connection results.

The inner tube method of treatment is so simple and so cheap that it has great possibilities in a country like India where people cannot always afford a pressure plant. On several occasions recently it has been reported that the cost of carting fence posts to a plant stationed at a central point, is often more than the cost of treatment. This is frequently the case in plantation work, and this simple method of treatment with inner tubes seems to be ideal for such work, as freshly felled posts can be treated *in situ,* and being green they will be ideal for the treatment. Old inner tubes can usually be bought up for a song, and even a badly torn tube will serve provided a serviceable length of 18 inches or so is available.

Any species of "junglewood" can be used, and the writer can see no reason why fence posts treated in this way should not give excellent service.

It may be mentioned that after treatment the bark should be removed from the posts. The posts should then be allowed to dry a few days before they are installed in the ground.

It is estimated that posts treated in the above manner with zinc chloride in the United States of America can reasonably be expected to last for 10 to 15 years, and possibly longer. The writer can see

no reason why posts treated in India with Ascu (which is far less leachable than zinc chloride) should not do equally well, if not better.

Some further experiments will be tried later, but in the meantime this note is published for the information of anyone interested.

NOTE ON THE BOUCHERIE OR SAP DISPLACEMENT PROCESS OF WOOD PRESERVATION

BY D. NARAYANAMURTI

Assistant, Wood Preservation Section, F.R.I.

The original Boucherie process employed copper sulphate as preservative. The process was extensively used in Europe for the treatment of poles, the main advantages of the process being cheapness (the plant equipment required is very simple) and thorough penetration of the sapwood with the preservative. The process was and is probably the only one by which *Picea excelsa* and *Abies pectinata* could be satisfactorily treated. The disadvantages of the process are: only freshly felled timber can be treated. The life of the poles was found to be short in areas where the soil had nitrogenous manure. This is attributed to to the leaching effect of water containing ammonia. The poles had also a short life in soil containing lime. The reason for this is that the calcium bicarbonate in the soil moisture reacts with the copper sulphate and converts it into copper carbonate which is insoluble and hence non-toxic to fungi. Apparently, due to these reasons, the treatment of poles by this process was dropped by the German post office about 1910. Recent analysis of statistical data regarding millions of telegraph poles treated with copper sulphate collected by the German post office shows that the average life of the poles must be over 30 years and probably even 40 years.* This high average life was attained in spite of copper sulphate being not specially highly toxic to fungi and the fact that it could be leached out or converted into non-toxic compounds in some locations. The process has again recently been taken up by the German post office

* Vide Bericht uber die Holztagung, 1935, p. 82, c.f. also F. Kollmann "Technologie des Holzes," p. 362, who rightly points out that data on the life of treated timber are only rough approximations,

using arsenic, flouride bichromate mixtures, since a fixation of the toxic salts on the wood fibre is obtained with these salts and no unfavourable chemical transformations take place in calcareous soils.* It is therefore to be expected that the life of the poles so treated should be over 40 years. Recent experiments in Germany with these new preservatives containing arsenic and dichromate showed that the penetration was complete in the sapwood throughout the entire length of the pole, that during the treatment no preferential fixation of individual constituents of the preservative takes place and that after lapse of sufficient time the composition of the solution flowing out of the pole was the same as the treating solution at the entering side of the pole (this was proved by careful chemical analysis). This shows that in this process the preservative passes through the entire pole unchanged in composition and that at the end of the treatment the sapwood cell paces are filled up with the preservative in approximately the original proportions. It is considered that on drying, these preservative salts are fixed on the fibres in a finely divided state and are not leachable.

The interesting experiments reported by Mr. Trotter show that the penetration is complete in the case of chir. As is well known chir is sometimes erratic regarding penetration. It is considered by many that pit aspiration lowers the penetrability of wood to liquids and it is believed that as the timber dries pit aspiration increases. If pit aspiration is the cause of erratic penetration in chir then the only obvious remedy is to treat the timber when it is quite green. Thus the Boucherie process will be very effective and it is the only one (apart from the osmose process) for treating green timber. The process is essentially a full cell one and the preservative is not economically used.

* The influence of soil conditions should be further investigated.

TIMBER PRICE LIST, JULY-AUGUST 1938

(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing	*Tetrameles nudiflora*	Assam	Logs	Rs. 30-0-0 per ton in Calcutta.
Benteak	*Lagerstrœmia lanceolata*	Bombay	Squares	Rs. 36-0-0 to 80-0-0 per ton.
,,	,,	Madras	Logs	Rs. 1-4-0 per c.ft.
Bijasal	*Pterocarpus marsupium*	Bombay	Logs	Rs. 42-0-0 to 84-0-0 per ton.
,,	,,	Madras	Logs	Rs. 0-11-4 to 1-3-1 per c.ft.
,,	,,	Orissa	Logs	Rs. 0-8-0 to 1-4-0 per c. ft.
Blue pine	*Pinus excelsa*	N. W. F. P.	12′×10″×5″	Rs. 4-4-0 per piece.
,,	,,	Punjab	12′×10″×5″	Rs. 4-12-0 per piece.
Chir	*Pinus longifolia*	N. W. F. P.	9′×10″×5″	Rs. 3-2-0 per piece.
,,	,,	Punjab	9′×10″×5″	
,,	,,	U. P.	9′×10″×5″	Rs. 3-4-0 per sleeper.
Civit	*Swintonia floribunda*	Bengal	Logs	Rs. 25-0-0 per ton.
Deodar	*Cedrus deodara*	Jhelum	Logs	
,,	,,	Punjab	9′×10″×5″	Rs. 4-0-0 per piece.
Dhupa	*Vateria indica*	Madras	Logs	
Fir	*Abies & Picea* spp.	Punjab	9′×10″×5″	
Gamari	*Gmelina arborea*	Orissa	Logs	Rs. 0-10-0 to 1-4-0 per c.ft.
Gurjan	*Dipterocarpus* spp.	Andamans	Squares	
,,	,,	Assam	Squares	Rs. 50-0-0 per ton.
,,	,,	Bengal	Logs	Rs. 30-0-0 to 35-0-0 per ton.
Haldu	*Adina cordifolia*	Assam	Squares	Rs. 1-3-0 per c.ft.
,,	,,	Bombay	Squares	Rs. 24-0-0 to 68-0-0 per ton.
,,	,,	C. P.	Squares	Rs. 0-13-0 per c.ft.
,,	,,	Madras	Logs	Rs. 1-3-0 per c.ft.
,,	,,	Orissa	Logs	Rs. 0-6-0 to 0-9-0 per c.ft
Hopea	*Hopea parviflora*	Madras	B. G. Sleepers	Rs. 6-0-0 each.
Indian rosewood	*Dalbergia latifolia*	Bombay	Logs	Rs. 52-0-0 to 100-0-0 per ton.
,,	,,	C. P.	Logs	Rs. 1-2-0 per c.ft.
,,	,,	Orissa	Logs	Rs. 0-12-0 to 1-4-0 per c.ft.
,,	,,	Madras	Logs	Rs. 2-2-5 to 3-12-0 per c.ft.
Irul	*Xylia xylocarpa*	Madras	B. G. Sleepers	Rs. 6-0-0 each.
Kindal	*Terminalia paniculata*	Madras	Logs	Rs. 1-4-0 to 1-5-6 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 36-0-0 to 72-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-12-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-12-1 to 0-14-2 per c.ft.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	Rs. 1-2-9 to 3-14-0 per piece.
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 31-4-0 to 75-0-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-3-0 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 20-0-0 to 75-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Rs. 0-8-0 to 1-3-0 per c.ft.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 to 5-0-0 per sleeper.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 1-10-0 per sleeper.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-0-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-0-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-14-3 to 5-4-0 per sleeper.
Sandalwood ..	*Santalum album* ..	Madras ..	Billets ..	Rs. 331-0-0 to 633-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Rs. 1-8-0 to 1-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-0-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 30-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	Rs. 1-0-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Rs. 0-12-1 to 1-1-10 per piece.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 0-14-0 to 1-6-6 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class	
,, ..	,, ..	,, ..	Logs 2nd class	
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-9-9 per c.ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 2-3-3 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-6-0 to 2-12-4 per c.ft.
,, ..	,, ..	Bombay ..	Logs ..	Rs. 68-0-0 to 140-0-0 per ton.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 3-8-0 each.
White dhup ..	*Canarium euphyllum* ..	Andamans ..	Logs ..	

REVIEWS

ANNUAL PROGRESS REPORT OF FOREST ADMINISTRATION IN THE UNITED PROVINCES, 1936-37

The advocates of the panchayat system for the management of village forests will be interested to read the high encomium that the report bestows on the success of panchayat management in Kumaun. With an area of 120,000 acres under the panchayats (which are of two kinds—official with a legal status and unofficial without any such status) this form of management can be said to have been given a very fair trial. The panchayats have constructed about five miles of boundaries (of walling ditches or hedges); have sown some three maunds of *chir* seed, 31 maunds of oak seed and have put out over 2,600 plants of various species. It is gratifying to learn of the development of a "forest sense" among the Kumaun villagers, but the report points out that scantiness of lopping material and extreme stages of forest deterioration (and the inconveniences caused thereby) are responsible for the awakening. In certain parts of the Punjab, the retrogression of the vegetation (as a consequence of excessive grazing and lopping) has been so pronounced and the dearth of fodder so acute that rules have been openly disregarded and the protection of forests has become a first-class problem of forest conservancy. Recently proposals have been made to adopt a panchayat management. Clearly no panchayat can be successful unless the individual villager respects the rules and is convinced that his existence and welfare are

indissolubly bound up with the conservation and intelligent utilisation of the forest produce. Viewed from this angle, the Kumaun villagers have set an excellent example.

2. To the best of our knowledge, the United Provinces Government is the first in India to appoint a fodder and grazing committee in pursuance of a resolution passed by the Animal and Husbandry Wing of the Board of Agriculture and Animal Husbandry (of the Imperial Council of Agricultural Research). The provincial committee has been active in preparing proposals for experiments and investigations for the approval of the Imperial Council of Agricultural Research. These experiments are of all-India concern and their progress will be watched with the greatest *interest*. The section on "Protection from Cattle" deals largely with the measures under consideration for increasing the fodder-yielding capacity of the forests. In the Afforestation Division experiments allowing grazing under varying conditions are being carried out, the basic idea being the greater utilisation of areas for grazing than for grass cutting. The average villager is very reluctant to stall-feed his cattle and it is extremely difficult to induce him to give up the age-long custom of grazing them. The results of these experiments will show what can be done to meet his wishes.

3. A claim is made (somewhat cautiously) to the discovery of the correct treatment for the development of the regeneration of Bhabar sal from the whippy to the sapling stage. The requirements are adequate light, protection, in varying degrees, from fire, deer and competing weeds. The problem of obtaining sal seedlings *de novo* on an adequate scale when and where desired and bringing them to the whippy stage still awaits solution. This species has been the subject of numerous papers and discussions but the report indicates that it may not be long now before the problem of its regeneration will be solved.

4. The area taken up each year for artificial regeneration continues to increase and during the year under review more than 3,500 acres were so regenerated. The Saharanpur *taungyas* come in for special praise and a pamphlet by Chaturvedi is promised on the subject. *Baib* grass plantations, although highly successful, have not been extended much on account of the limited demand but with the development of the paper industry, these conditions are rapidly

changing and we may expect to see increased attention being paid in the near future to the creation of plantations of this grass.

5. *Usar* land under protection is now reported to be yielding 16 maunds of grass per acre. It would be of interest to know the nutritive value of the grasses obtained and whether the cattle take to them easily or not. The chir resin experiments indicate that two inches deep tapping is most productive and that trees with twist give a higher yield than straight-grained trees. The Forest Research Institute is investigating the possibility of *Pinus longifolia* for mechanical paper pulp. The experiment will be watched with considerable interest by all *chir*-producing divisions.

6. The report throughout stresses the need for a more generous allotment of funds. The department needs more money for the improvement of the housing of its subordinates, for more intensive fire protection measures, for the tending of the growing stock, for forest dispensaries, etc.

A department, which has never failed to show a satisfactory surplus, and in the year under report a surplus of nearly Rs. 17 lakhs, is surely deserving of adequate funds for the above objects.

7. Financial results are very encouraging to the tax-payer as the forests continue to yield a substantial surplus. Gross revenue less refunds amounts to Rs. 44,35,302 and the expenditure to Rs. 27,62,041 which gives a surplus of Rs. 16,73,261 against Rs. 21,36,171 during 1935-36. The fall is not serious as it is merely due to less produce being available for sale. *Khair* trees are reported to have fetched low prices owing to heavy competing *khair* fellings in Nepal. The Tarai and Bhabar Government Estates forests (which are included for the first time in the Annual Report) show a surplus of Rs. 1,63,373 (revenue Rs. 2,57,449, expenditure Rs. 94,076).

N. P. M.

INFLUENCE OF MEDITERRANEAN FORESTS ON CLIMATE

A paper under this title written by Professor Aldo Pavari of the Italian Forestry School in Florence and printed in the proceedings of the Italian Accademia dei Georgofili 1936 XV was borrowed from the Librarian, Imperial Forestry Institute, and as it contains fresh data on this very debatable subject, some notes on it may be of interest to your readers.

The author has tried to assess the climatic influence of forest in two parts: (*a*) the effect on the interior and immediate neighbourhood of the forest and (*b*) the effect at a distance, but only results under (*a*) are published. The forests chosen for the test were on the Terranean coast near Livorno, one being high forest of *Pinus pinca*, the common Stone pine, and the other being a much denser cover of oak, mostly 12-year-old, *Quercus ilex*. These were selected as being common types but not necessarily climax forest. The measurements taken were: air temperature at 1½ metres (5 feet) above ground; relative humidity; rainfall; wind velocity; evaporation by a Livingstone atmometer; and temperature of soil at depth of 20, 50, 75 and 100 centimetres. Out of the results published by Pavari one set of data is reproduced comparing pine, oak and open ground at a place called Cecina, within a mile of the seacoast and 8 metres above sea-level.

From these and other stations up to four kilometres from the sea Pavari has summarised his conclusions as follows:

1. Compared with readings in the open, forest canopy modifies the temperature considerably but relative humidity is not greatly influenced.

2. The amount of rainfall registered inside the pine wood was reduced to 73.7 per cent. of that in the open, but for single storms the differences in performance in this respect are very striking and contradictory.

3. Daily evaporation is greatest in summer, and the total for the year is 1,387 mm. for oak forest as compared with 2,372 mm. for the open.

4. The main forest effect is a shielding one which reduces the wing. This effect stops short at the margin of the wood and border stations show transitional features, the maximum temperature on the edge being higher than right outside.

R. M. G.

KILN-SEASONING TREATMENTS OF TEAK AND THEIR EFFECTS ON ITS WEARING QUALITIES AS FLOORING

BY KNIGHT, DEAN AND ARMSTRONG.

(*Forest Product Research Records, No.* 23, *London: H. M. Stationery Office,* 1938.)

Teak is being exported to England from Burma in large quantities in the form of 4 inches by 1 inch strips for flooring, for which purpose it is an ideal wood on account of its low shrinkage and hygroscopicity and high resistance to wearing. Drying kilns have been installed for this work by one firm at Moulmein, but most of the timber shipped is freshly sawn and for this reason the kiln-drying of teak flooring strips in Great Britain is assuming importance.

The first part of this record contains data on the kiln-drying of six charges of teak flooring carried out at the Forest Product Research Laboratory, Princes Risborough, and, based on these treatments, a general schedule is recommended, which is said to be safe, speedy and to produce dried timber of uniform moisture content. The schedule recommended should give good results.

In the second part, Armstrong deals with the wearing qualities of teak flooring dried at different conditions of temperature and humidity, and comes to the conclusion that use of high temperatures for kiln-seasoning of the order employed in the investigation is not detrimental to the wearing qualities of the timber. Out of the strength properties, maximum bending strength and resistance to indentation are not affected by the temperature of drying, but the resistance to shock is lowered by drying at high temperature.

S. N. K.

ABSTRACTS OF INDIAN FOREST LITERATURE ISSUED DURING THE QUARTER ENDING 31ST MARCH 1938, TOGETHER WITH ABSTRACTS OF ARTICLES PUBLISHED IN THE "INDIAN FORESTER"

GARDNER, J. C. M. *Immature Stages of Indian Coleoptera* (23), *Carabidae. Ind. For. Rec.* (E) *III* (8): 149—157, *pls.* 2. 1938.—Larvae of the following species are described and figured: *Omophorn smaragdus* And., *Harpalus indicola* Bates, *Ophonus indicus* Bates, *Tachys umbrosus* Motch., *Chlaenius punctatostriatus* Chaud., *Chlaenius circumdatus* Brull., *Tetragonoderus elegans* Andr.—*Author's Abstract.*

CUSHMAN, R. A. *Four new Indian Ichneumonidae. Ind. For. Rec.* (*E*) *III* (7): 141—147. 1937.—In this paper four new species are described: *Calliephialtes bimarginatus* n. sp. (Dehra Dun, United Provinces, India), *Exochus semiflavus,* n. sp. (Gorakhpur, United Provinces, India), *Enicospilus flavoplagiatus,* n. sp. (Dehra Dun, United Provinces, India), *Aphanistes eupterotes,* n. sp. (Dehra Dun, United Provincs, India).—*C. F. C. Beeson.*

KRISHNA, S. and T. P. GHOSE, *Indian Tephrosia* sp. *as a source of rotenone. Current Science,* 45, March 1938.—Root bark of *Tephrosia candida* has been found to contain 0.35 per cent. and the seeds 0.5 per cent. of rotenone. The leaves also contain rotenone as indicated by colour test. Root bark of *Tephrosia purpurea* showed presence of rotenone (less than 0.3 per cent. colour test positive).—*Author's Abstract.*

CHOPRA, R. S. *The depth and frequency of irrigation in plantations. Punjab For. Rec.* (*S*) *I* (4): 1-15. 1937.—Results of experiments to determine the best depth and frequency of irrigation in the plantation of *Dalbergia sissoo* in the Punjab desert show that varying the depth from 3 feet to 6 feet causes no appreciable improvement in growth, and that 6-inch irrigations give better results than 3-inch irrigations using a total depth of 3 feet. this quantity being adequate for the successful raising of a tree crop. Irrigation requirements are, however, greatly affected by rainfall, which varies from 2.34 inches to 25.68 inches annually averaging 8.66 inches.—*M. V. Laurie.*

MOONEY, H. F. *A synecological study of the forests of Western Singhbhum with special reference to their Geology. Ind. For Rec.* (*S*) *II* (7): 259-356, *pls.* 21, *map* 1. 1938.—This paper attempts to classify on an ecological basis the chief types of forest vegetation met with in the western half of Singhbhum district, where the natural flora has suffered least disturbance by man. Attention is drawn to the various factors influencing the distribution of species, but special emphasis is laid on the important role played by geology in determining vegetational changes in an area where the climate varies within narrow limits. The relation of the principal communities to the climatic climax is examined and their ecological status indicated, details of their floristic composition being given in some detail. Secondary succession is discussed and an endeavour is made to trace the cause of the more important subseres,

The main types of forest described are: (*i*) Driest type (*Cochlospermum-Euphorbia*), (*ii*) Dry mixed deciduous (*Mitragyna-Anogeissus, Dendrocalamus, Dædalcanthus*), (*iii*) open grassy dry *Shorea robusta* mixed types (*Shorea-Anogeissus-Woodfordia*), (*iv*) open grassy dry *Shorea robusta type* (*Shorea-Gardenia-Pollinidium*), (*v*) High level plateau *Shorea robusta* (*Shorea-Bauhinia-Themeda*), (*vi*) Moist hill *Shorea robusta* (*Shorea-Wendlandia-Indigofera*), (*vii*) Valley *Shorea robusta* (*Shorea-Flemingia-Imperata*), (*viii*) Damp valley *Shorea robusta* (*Shorea-Polyalthia-Croton*) (*ix*) Moist mixed forest (*Terminalia-Mallotus-Combretum*) (*x*) Low level evergreen forest (*Mangifera-Amoora-Uvaria*), (*xi*) *High level evergreen* (*Michelia-Meliosma-Anodendron*), (*xii*) Damp ravine or swamp type (*Licuala-Melastoma-Scleria*).—*M. V. Laurie.*

PARKER, R. N. *Collett's Flora Simlensis. Ind. For. LXIV* (1): 3-7. 1938.—A few species found in the Simla neighbourhood are mentioned as having been omitted from Collett's Flora Simlensis and as they are not numerous it is concluded that the Flora was reasonably complete. Changes that have taken place in the vegetation are the disappearance of the more ornamental plants due to picking flowers and digging up roots. Additions have occurred owing to exotic weeds and garden plants becoming established of which a list is given.—*Author's Abstract.*

BANERJI, J. *Silvicultural Experiments, Ind. For. LXIV* (1): 7-14. 1938.—The present system of "Paired Plots" is examined and is considered unsatisfactory; if used, Fisher's t-method, or Mahalanobis' f-table should be used for computation of significance. A system of Randomized Blocks is recommended for silvicultural experiments. After analysis of Variance, Fisher's z-table or Mahalanobis' x-table should be employed for testing significance of results. A plea is made out for more detailed, well laid out and complicated experiments.—*Author's Abstract.*

KAMESAM, S. *Standardisation of treated wood pole sizes for overhead electrical transmission supports. Ind. For. LXIV* (1): 43-48, 1938.—Gives tables of dimensions and strength data for wooden poles classified into three strength catergories, with lists of Indian species belonging to each category.—*M. V. Laurie.*

PRING, N. G. *Single Tree Silviculture in Indian Forests. Ind. For. LXIV* (1): 52-53. 1938.—Criticises Dr. Gorrie's article (*Indian Forester,* October 1937), advocating free thinnings, on the basis of the danger of selecting the final trees so early, the loss of increment and value on the whole crop, and the difficulty in utilising the trees other than the "èlites."—*M. V. Laurie.*

TAKLE, G. G. *Yield of gum from Kullu trees. Ind. For. LXIV* (1): 54. 1938.—Gives data for the yield of gum per season from *Sterculia urens* trees. These average 29 tolas per tree per annum for the Melghat Division of the Central Provinces, which is less than that reported for Damoh Division, namely 1 seer (=80 tolas) per tree per year.—*M. V. Laurie.*

GERALD TREVOR. *Effect of burning of slash on soil and succeeding vegetation. Ind. For. LXIV* (2): 81-82. 1938.—Indian experience appears to be contrary to that reported from Germany (Fabricius) and by Heikinheino who showed that ash was never beneficial and often harmful, reducing germination per cent. of tree seeds and development of the seedlings. For teak regeneration and dry forest regeneration ("rab work") burning is highly beneficial and considered essential, as also for ecological reasons in regeneration of *Shorea robusta* forests. It is suggested that the effect of fire in the tropics may be different from that in temperate regions.—*M. V. Laurie.*

SINHA, J. N. *State control over private forests in Finland. Ind. For. LXIV* (2): 96-101. 1938.—Private owners of forests in Finland are not allowed to treat their forests as they like, but must obey the provisions of the "Law Concerning Private Forests" (1917, revised 1928), which is enforced by the Private Forest Supervision Section of the Forest Department. The functions of the Central Forestry Association and District Forestry Boards are described.—*M. V. Laurie.*

GORRIE, R. M. *Crown ratio in Indian conifers. Ind. For. LXIV* (2): 101-4. 1938.—Reports recent Australian work on the use of crown ratio (*i.e.* ratio of diameter at breast height to the average crown width) as a guide to spacing in thinnings, and discusses its application to Himalayan conifer crops. A critical note by Laurie follows, pointing out some difficulties in the simple direct application of crown ratio to determine spacing in thinnings.—*M. V. Laurie.*

GARLAND, E. A. *Forests and Man. Ind. For. LXIV* (2): 107-12. 1938.—Talk broadcast from Bombay (V.U.B.) on 25th July 1937 describing the effects of forests on the formation of man's philosophies and religions through the ages, the assistance which wood has been to man in the development of his civilisation, and the life led by a forest officer in India.—*Author's Abstract.*

TROTTER, H. *Brush treatments with wood preservatives. Ind. For. LXIV* (2): 113-16. 1 *pl.* 1938.—The best method of applying brush treatments with wood preservatives is described along with the limitations of this process.—*Author's Abstract.*

DE, R. N. *Sal Inflorescence. Ind. For. LXIV* (2): 125. 1938.—Reports observations of different coloured inflorescences in *Shorea robusta* and suggests the possibility of there being definite different varieties of the trees.—*M. V. Laurie.*

GORRIE, R. M. *Stone bunds in erosion control. Ind. For. LXIV* (3): 149-50. 5 *pls.* 1938.—Describes the wrong and right ways of constructing rough stone bunds for control of gullying, special note being made of the best spacing and proper contouring of the top of the bunds.—*M. V. Laurie.*

CHENGAPA, B. S. *Padauk in the Andamans. Ind For. LXIV* (3): 151-60. 1938.—In this note the writer examines the behaviour of padauk (*Pterocarpus dalbergioides*) in the plantations of the past and also its behaviour in the natural regeneration areas of the present. Particular stress is laid upon the failures in past plantation work and the cheap and successful natural regeneration that is now being obtained.—*M. V. Laurie.*

MASCARENHAS, L. P. *Forests of Janjira State. Ind. For. LXIV* (3): 160-68. 1938.—Briefly describes the geology, climate and forests of Janjira State. The forests are a moist mixed deciduous type, *Tectona grandis, Dalbergia latifolia, Terminalia tomentosa, Grewia tiliæfolia* being the chief species. Past management is described. The forests are worked chiefly for firewood and poles on the simple coppice system, regeneration being supplemented artificially by sowings.—*M. V. Laurie.*

VAHID, S. A. *Departmental exploitation of forests in Nimar division, C. P. Ind. For. LXIV* (3): 1 *pl.* 12 *figs.* 168-80. 1938.—As contractor's work in the forests of Nimar division, Central Provinces, was found to be unsatisfactory departmental exploitation of

these forests was started in 1923. With experience, improved methods were introduced and the results to-day are very satisfactory. Whereas sales at Khirkiya depot in 1926-27 amounted to Rs. 111 in 1936-37 these amounted to Rs. 1,15,912.—*Author's Abstract.*

GARLAND, E. A. *The future of forests. Ind. For. LXIV* (3): 181-5. 1938.—This broadcast talk, given from Bombay (V.U.B.) on 26th September 1937, sketches in rough outline the part which forestry is capable of playing throughout the world in the development of the resources of the soil in the most economic manner. It admits the futility of any attempt to prophesy what may happen, politics all over the world being in their present uneasy state, but indicates some of the ways in which forests could, and should, contribute to man's well-being. Crops of trees and grasses are not only essential in some climatic and physiographic conditions, they are also capable of development, like any other agricultural crops, as the basis of raw materials for industries. To grow trees and establish their associated industries can also automatically involve the creation of living conditions for the workers which tally closely with the modern ideal. This transposes the old Latin tag "*rus in urbe*" into "*urbs in rure.*" Japan already practises what we preach.—*Author's Abstract.*

GORRIE, R. M. *Twisted fibre in Pinus excelsa. Ind. For. LXIV* (3): 1 *pl.* 185-86. 1938.—Describes the occurrence (rare) of twisted fibre in *Pinus excelsa.*—*M. V. Laurie.*

(*To be continued.*)

EXTRACTS

INDIA AIDS THE SUDAN

One of the problems of the Sudan is the provision of a satisfactory windscreen for the protection of plantations, etc. The utility for this purpose of the *neem* (*Azadirachta indica*) tree of India, which is now acclimatised in the Sudan, is referred to by the *Sudan Daily Herald*, which mentions how valuable this tree has proved in changing the appearance of whole areas.

Unfortunately, it appears that insufficient use has been made of this tree so far, this being attributed to the difficulty in obtaining adequate supplies of seedlings. This problem will no longer exist, however, as the Forest Department is now offering the free distribution of a large number of young trees.—(*Great Britain and the East*, 30th June 1938.)

MIXTURE OF SPECIES IN PLANTATIONS

BY MR. R. I. MACALPINE, I. F. S.,

Deputy Conservator of Forests.

It is difficult to dogmatize on the standardization of mixtures in terms of rotation, uses, locality, etc., firstly as our information for fixation of rotation can only be based on indications given by stem analyses, which for some species are yet too few to rely upon. For the purpose of grouping of species according to rotation, however, the actual rotation is not important. While the rotation is actually shown in the statements below, it should be noted that these may be revised later.

The two curves (*not reproduced*) B. H. G./Age must therefore be taken with reserve. They are primarily intended to show ages at which various species may be expected to attain 6′ girth over bark, but this, it will be realized, does not give any data on quality increment. Until we have collected sufficient information regarding "heartwood and sapwood" at different girths, the rotation groupings below must only be treated as provisional.

Again, it is perhaps worthy of consideration that as the girth of a tree increases, volume increases rapidly. Thus under $\frac{1}{4}$ girth measurement the volume of an 8′ girth log 50′ long is nearly double that of a 6′ girth log of similar length. Yet this represents only a diameter increment of .7 inches.

All these points should therefore be considered together. From the graph (*not reproduced*) it is obvious no definite grouping is possible without increasing the number of groups excessively and to avoid

this the following rotations are suggested:—

I—NORTH BENGAL

Plains and Foothills.

Group I.—Rotation 40 years.

Species.		B.H.G. at 35 years. Feet.	B.H.G. at 40 years. Feet.	B.H.G. at 45 years. Feet.
Michelia champaca	...	6.0	6.9	7.6
Duabanga sonneratioides	...	5.8	6.5	7.4
Ailanthus grandis	...	5.7	6.5	7.1
Gmelina arborea ...	...	5.5	6.3	6.9

Probably to the above may be added—

(1) *Bombax* spp.
(2) *Tetrameles nudiflora.*
(3) *Acrocarpus fraxinifolius.*
(4) *Anthocephalus indica.*

Group II.—Rotation 60 years.

Species.		B.H.G. at 55 years. Feet.	B.H.G. at 60 years. Feet.	B.H.G. at 65 years. Feet.
Cedrela toona	...	7.1	8.0	8.4*
Chukrassia tabularis	...	7.1	8.0	8.4*
Trewia nudiflora	...	7.4	7.8	8.2*
Terminalia myriocarpa	...	7.0	7.4	7.8
Terminalia crenulata	...	6.6	7.0	7.4

*By interpolation.

Probably here may be added—

(1) *Adina cordifolia.*
(2) *Artocarpus chaplasha.*
(3) *Cinnamomum cecidodaphne.*
(4) *Swietenia macrophylla.*
(5) *Albizzia procera.*

Rotation 80 *years.*

Species		B.H.G. at 75 years. Feet.	B.H.G. at 80 years. Feet.	B.H.G. at 85 years. Feet.
Dalbergia sissoo	...	6.6	7.0	7.4*
Lagerstrœmia flos-reginœ	...	6.5	6.8	7.0*

*By interpolation.

To these may be added probably—

(1) Sal (judging from Haines' plantation).

(2) Teak (judging from Heinig's plantation in Chittagong Hill Tracts and also Bamanpookri).

(3) *Albizzia odoratissima.*

(4) *Albizzia lebbek.*

(5) *Phœbe hainesiana.*

(6) *Phœbe attenuata.*

(7) *Swietenia macrophylla* (for big timber).

HILLS.

Rotation 50 years.

Species.		B.H.G. at 45 years. Feet.	B.H.G. at 50 years. Feet.	B.H.G. at 55 years. Feet.
Cryptomeria japonica	...	7.1	7.6	8.0
Alnus nepalensis ...	...	6.5	7.0	7.4*
Macaranga pustulata	...	6.1	6.6	7.0

*By interpolation.

Rotation 60 years.

Species.		B.H.G. at 55 years. Feet.	B.H.G. at 60 years. Feet.	B.H.G. at 65 years. Feet.
Betula alnoides ...	...	6.6	7.0	7.4*
Betula cylindrostachys	...	6.1	6.6	7.0
Juglans regia ...	...	5.9	6.4	6.7
Machilus gammieana	...	5.5	6.0	6.4

*By interpolation.

Rotation 100 years.

Species.		B.H.G. at 90 years. Feet.	B.H.G. at 100 years. Feet.	B.H.G. at 110 years. Feet.
Michelia lanuginosa	...	7.0	7.5*	7.9*
Michelia excelsa ...	...	6.2	6.7	7.2
Acer campbellii ...	...	5.9	6.6	6.8
Bucklandia populnea	...	5.7	6.2	6.5
Prunus nepalensis	...	5.5	5.7	6.2

*By interpolation.

Probably the oaks and chestnuts would come under this group.

II.—SOUTH BENGAL

Our knowledge of species here is extremely limited. It is presumed that rotations would be the same in Southern Bengal as in Northern Bengal for the species which occur in both localities. Other species, however, are unknown quantities and until further information is obtained, all that can be done is to relegate spp. to *Long* and *Short Rotation.*

Long Rotation, not less than 80 years—

Dipterocarpus spp.
Anisoptera glabra.
Hopea odorata.
Dichopsis polyantha.
Swietenia macrophylla.
Artocarpus chaplasha (for big timber).
Lagerstrœmia flos-reginæ.
Tectona grandis.
Eugenia spp.
Lophopetalum fimbriatum.

Short Rotation, not less than 50 years—

Gmelina arborea.
Artocarpus chaplasha.
Bombax spp.
Anthocephalus indica.
Trewia nudiflora.
Sterculia alata.
Tetrameles nudiflora.

Mixtures.—It is only within recent years that any organized experiments in mixtures have been undertaken, and it is obvious that the success of such can only be definitely estimated when the crop is well advanced. For future plantation policy we must accept in the meantime the indications given by the various mixtures so far experimented with.

Method of forming mixtures.—It is, I believe, generally accepted now that the somewhat intricate and mechanical methods of mixtures experimented with are somewhat impracticable in divisional working

and simpler methods are indicated. The following appear to be practicable:—

(1) Alternating groups of strips,
(2) Alternate lines,
(3) Mixed seed sowings in lines,
(4) "Quincunx,"

and of these (1) is by far the most promising and can be combined with (3).

Under certain circumstances, "patch" sowings or planting may be advisable, *e.g.*, Oaks in coppice coupes.

Principles to be followed in forming mixtures.—(*i*) Species not found pure in natural forest should be grown in mixture.

In this connection the following species may be considered naturally gregarious:—

Sal (*Shorea robusta*).
Sissoo (*Dalbergia sissoo*).
Teak (*Tectona grandis*) (with bamboo).
Telsur (*Hopea odorata*) (in small patches).
Garjans (*Dipterocarpus* spp. (particularly *D. costatus* and *D. turbinatus*).
Tali (*Dichopsis polyantha*) (doubtfully gregarious).
Nageswar (*Mesua ferrea*).
Simal (*Bombax* spp.).
Conifers (generally pure).

(*ii*) Mixtures of rotations should be avoided in any one unit of area. By this it is meant that species of widely varying rotations should not be grown together, unless it is intended that one or more spp. should be cut out, as a "catch crop" and that others will remain to full rotation. (In such cases mixtures would be intimate to ensure final adequate stocking of the long rotation species.)

Thus, to take an extreme example, it would not be wise to mix *champ, gamhari, jarul* and *nageswar* under the alternating groups of strips method, but *jarul* and *gamhari* in alternate lines would be permissible.

(*iii*) An excessive number of species should not be put out in any one small unit of area so that there will be adequate multiplication of individual strips or lines. Similarly, if the plantation area is a

long narrow strip, the lines or strips should be at right angles to the longer axis.

(*iv*) Species of the same botanical families, of which one or more individuals are known to be insect tender, should be separated by other species, as it is generally a fact that an insect is liable to attack all species in a family.

Thus *toon* and *mahogany* should be separated, similarly *champ* and *magnolia*, etc.

(*v*) *Tending*.—If in a mixture, owing to various reasons, such as excessively fast growth of one species, it is found that another is liable to be killed out, the latter should be favoured somewhat to preserve the mixture. This should only be necessary in the early stages of a plantation, and if it is found that the slower grower fails to respond, it may be taken as an indication of unsuitability of the mixture.

Notes on Methods.—(*i*) *Alternating groups of strips*.—There is little to add to the note issued by this office forwarded under No. 469-75/1E-5, dated the 17th April 1934. The danger of mixture of rotations is minimised by this method as long as species of widely varying rotations are not used. It is probable that the final crop will be worked something in the nature of a selection system.

(*ii*) *Alternate lines*.—This method is best suited to the formation of (*a*) permanent mixtures of a light demander and a shade bearer (of approximately equal rotations), or (*b*) temporary mixtures of a fast and slow grower.

(*a*) It is difficult to find ideal combinations for this purpose, the best so far known being *panisaj* and *angare* (*phœbe attenuata*) and further research is needed.

There would appear to be no perfect mixtures for the Hills except perhaps birch and *machilus* in the 60 years' group and *Acer* or *Prunus* with *pipli* in the 100 years' group.

(*b*) For this type of mixture it is essential that the catch crop will maintain a lead but at the same time permit of the longer rotation species to grow. It is obvious that the catch crop must be opened out fairly quickly and the number of trees at rotation will be less than what the species might be expected to produce if pure.

No ideal mixture has yet been proved, but the following show indications of promise: —

(1) *Gamhari* and *Garjan*.
(2) *Gamhari* and *Tali*.
(3 *Gamhari* and *mahogany* (mahogany poor to begin with but will possibly recover as canopy of *gamhari* rises).
(4) *Utis* and *Phusre Champ* (*Michelia lanuginosa*).
(5) *Utis* and *Champ* (*Michelia excelsa*).
(6) *Pitali* and *Jarul*.

Possibly other suitable mixtures might be found among the following: —

Madane and *Phœbe* spp. (*Bonsum* and *Angare*).
Maine and *Phœbe* spp. (*Bonsum* and *Angare*).
Birch and *Champa* (*Michelia excelsa*).
Birch and *Phusre Champ* (*Michelia lanuginosa*).
Birch and *Pipli*.

(*iii*) *Mixed line sowings*.—The object of this method is to raise a two-storey crop, at least in the earlier stages, so that the lower storey will form a soil cover when thinnings in the upper canopy are made.

Mixed seed of the required species are sown, the mixture being so proportioned in terms of germination per cent. of the seed used to ensure the correct intensity of stocking.

An example of this mixture is *panisaj* and *chukrassi* in the proportion of 16 to 1.

Mandane and *toon*, *mandane* and *chukrassi* show promise in this method. The so-called "Lucky bag mixtures" of Mechi in Kurseong division are interesting, *toon*, *gamhari*, *chukrassi*, *lampate*, etc., all being sown from indiscriminate mixtures of seeds. Difficulties in cultural treatment arise in this method but results are very fair and plantations more closely approximate to natural forest. This method has the advantage in that species of differing rotations may be grown together, the forest being treated something in the nature of a selection forest as individual species reach maturity. This method requires further study

(*iv*) "*Quincunx*"—A useful method for covering the soil quickly. It allows of wider spacing of the main species which is sometimes necessary on account of shortage of seed or of seedling stock. This method has been very effective with teak and bamboo, the latter "Quincunx" and has also been tried with *gamhari*. The method can be used for mixtures of species of similar rotation, or of different rotation.

Standard mixtures.—As stated above "standardization of mixtures" would be unwise, but the following mixtures have shown promise of success:—

Alternate lines.—

Plains—

Panisaj and *Angare*.
Panisaj and *Jarul*.
Gamhari and *Tali*.
Gamhari and *Garjan*.
Gamhari and Mahogany.

Hills—

Utis and Hill *Champ*.
Utis and *Pipli*.
Utis and *Phusre Champ*.

Other possible mixtures in alternate lines may be found in—

(1) *Pitali* and *Jarul*.
(2) *Panisaj* and *Bonsum* (*Phœbe hainesiana*).
(3) Birch and *Pipli*, *Phusre Champ* and Hill *Champ*.

Our knowledge of alternate line mixtures is meagre and further experiment in terms of species noted under the rotation groups above would be of interest.

Mixed line sowings.—The following show promise:—

Panisaj and *chukrassi*	...	P 16: C 1.
Panisaj and *Toon*	...	P 15: T 1.
Panisaj and *Jarul*	...	P 8: J 1.
Mandane and *Chukrassi*	...	M 1: C 1.

Also the lucky bag mixtures of *panisaj*, *chukrassi*, *toon*, *haldu*, *gamhari* are worthy of consideration.

"*Quincunx.*"—Teak $6' \times 6'$ with seedlings of *Bambusa tulda* in Chittagong Hill Tracts appear excellent. It is suggested that teak stumps $9' \times 9'$ with bamboo in quincunx would be a successful mixture. Rhizome bamboos are probably better than clump bamboos for this purpose but probably with even such a clump as is produced by *Bambusa polymorpha,* teak would show less epicormic branching than is now evinced in Northern Bengal plantations.

Similarly, *gamhari* with bamboo is worthy of consideration.

Alternating groups of strips.—No definite conclusions can be reached at this stage in connection with mixtures so far experimented with, but it is suggested that future mixtures should be put out with due regard to the notes on the formation of mixtures above and in particular the avoidance of mixing species of widely varying rotations.

General.—The primary objects of forming mixtures is to reduce the danger of complete annihilation of a plantation by pests and also to obtain per unit of area more than one saleable species.

Thus thinnings must be very carefully done in order to retain the mixture.

An example of the difficulty in connection with this point occurred recently, where a thinning was being done in a mixed plantation of *panisaj, toon, gamhari* and *chukrassi* (1923). *Panisaj* was generally well above the other species. *Toon* in particular appeared suppressed. During the course of thinning by a Deputy Ranger, he apparently considered that the lower canopied trees were suppressed and was marking these for thinning, which operation tended to reduce the crop to one of pure *panisaj.*

It is obvious that thinnings in mixed plantations must be done with due regard to the growth on the various species forming the mixture, *i.e.,* that thinnings should be done for various canopy levels, the heaviest occurring in the upper canopy.

Again, it is once more emphasised that slashing of undergrowth in the course of thinnings, climber cutting or thinning is against the objects of mixtures.

It is a surprising fact that practically all our valuable miscellaneous species are deciduous or semi-deciduous, with the result that a plantation exhibits a totally different appearance to the natural forest from which it was formed. In the Chittagong Hill Tracts it

was observed that in dry areas chapalish, normally a semi-deciduous species, became completely leafless in the hot weather for some years, and even *Dichopsis polyantha* (tali), an evergreen, was leafless in open plantation during the hot weather, and the retention of natural coppice or seedling growth, even of useless species, to prevent dessication of surface soil cannot but be advantageous.

In conclusion it will be observed that while an attempt has been made above to point out proved mixtures, our knowledge is meagre, and there are still further possible combinations for experiment.

It is also suggested for consideration whether the addition (for various purposes, such as soil cover, etc.) of commercially valueless species to our mixtures may not be of ultimate benefit.—(*Extracted from the Proceedings of the Indian Forest Service Officers' Conference at Darjeeling, 27th September to 2nd October* 1937.)

HISTORY OF THE MAL BLOCK OF THE KALIMPONG DIVISION

By W. E. Hodge, I.F.S.

Divisional Forest Officer, Kalimpong Division

The history of the Mal Block is of interest as for many years this block has had a bad reputation as the worst type of forest and has been used as an example of what a forest under systematic control ought not to be. It is also of interest to see the result of systematic control for a whole rotation on a forest which was not in normal condition when it came under the management of the Department in 1881.

The forest consists of a self-contained block of 6,107 acres, lying roughly between the Chel river on the west and the Neora river on the east and between the Fagu Tea Estate on the north and the Jalpaiguri district on the south. The area is almost flat except for a low ridge forming the west bank of the Mal *khola*, and is intersected by numerous small streams whose general direction is from north to south, the most important of which are the Mal *khola* and the Burri *khola*.

The elevation above sea level is from 600 feet at the south boundary to 1,000 feet at the top of the above mentioned ridge.

The soil consists of a reddish, loamy clay of fertile character, except where rivers have had their beds within recent times. In the latter areas the soil is rocky and shallow and is not capable of producing trees of such vigorous growth as the former.

The climate is very moist and humid during the greater part of the year and is generally a very unhealthy one.

The first detailed description of the forest that was written is found in the Working Plan for the Mal Block, written by Mr. J. W. A. Grieve; in 1902 he wrote:—

"Two types of forest are represented—(*a*) Forest occurring on stony, shallow soil on areas which, within comparatively recent times, have formed river beds. This type of forest is very open, and the canopy is nowhere complete; large isolated specimens of *udal* (*Sterculia villosa*), *mainakat* (*Tetrameles nudiflora*) and *simal* occur, together with almost pure groups of *lampatia* (*Duabanga sonneratioides*), with an undergrowth of grass and creepers..

Throughout the better drained areas scattered specimens of sissu (*Dalbergia sissoo*) occur, and in the sandy beds of the Neora and Chel rivers this species is found in groups.

(*b*) The second type of forest is characterised by a rich, red loamy clay of very fertile character. It contains an enormous number of species, of which *panisaj* (*Terminalia myriocarpa*), *lampatia*, *malagiri* (*Dehaasia* spp.), *Michelia champaca*, *Elœcarpus* spp. are the most important. *Mesua ferrea* occurs in the damper portions almost pure, and cane grows luxuriantly along the banks of the smaller streams. Owing to the land having been jhumed in former years and to the fact that the forest has been heavily overfelled, the leaf canopy is incomplete, except in rare instances where groups of *panisaj* of very large size mixed with *lampatia* occur.

Areas devoid of tree growth and covered with an impenetrable mass of creepers and herbaceous growth are of frequent occurrence. . . . The creeper growth is enormous and is a great bar to natural production. Coppice shoots are also liable to be choked by the creepers and it is a matter of great difficulty to get these properly cut. . . . Owing to the comparatively small area of plains forest in the neighbourhood where they can get fodder, elephants do considerable damage. It is probable that they will be one of the most serious objects to be contended against in artificial regeneration."

Systems of management.—The forest appears to have been worked under unregulated selection fellings up to 1896 when the first Working Plan for the Tista Division was written by Mr. H. D. D. French, Deputy Conservator of Forests. In this plan it was laid down that only dry and fallen trees should be removed for the next 10 years as the forest had been jhumed and heavily worked.

The demand for fuel from neighbouring tea gardens increased enormously and in 1900-01 it was decided to convert the forest from irregular high forest to coppice under standards and with this object two coupes were laid out and all inferior species removed, nearly all the valuable species being retained. The work was not done satisfactorily, large trees being left uncut and the stumps destined to produce coppice shoots not being cut flush with the ground.

In 1902 a separate plan for this forest was prepared by Mr. J. W. A. Grieve, Deputy Conservator of Forests, the system prescribed being coppice with standards, the latter being restricted to 20 to 30 per acre. The rotation for the coppice was fixed at 25 years, whilst standards were to be kept for two or three rotations as was found necessary. A minimum diameter of 18 inches was fixed, pending the collection of more data at which standards could be felled.

Regeneration was to be assisted by the planting of blank areas, by clearing lines 4 feet wide and 20 feet apart. *Thallis* 3 feet × 3 feet × $1\frac{1}{2}$ feet were to be made 10 feet apart and these lines were to be kept clear for two years after planting.

By the end of 1905-06, 1,182 acres of the forest had been worked over and cultural operations as prescribed by Grieve carried out over 772 acres, consisting of planting up blanks in the coppice areas. It was stated that "where the plants have escaped being trodden down by elephants, they are doing well."

In 1907 the first Working Plan for the Tista Division having expired, it was replaced by the second plan prepared by Mr. P. Tinne, Deputy Conservator of Forests, and although the period (25 years) of the subsidiary plan for the Mal forest had not expired, the forest was included in the second plan.

In this plan coppice with standards was again prescribed, the rotation for the coppice being reduced from 25 to 20 years. No limit was fixed for the number of standards to be retained. All sound

and well shaped trees of the following species were to be retained:— *Sal* (*Shorea robusta*), *champ* (*Michelia champaca*), *lampate* (*D. sonneratioides*), *ghamar* (*Gmelina arborea*), *dudhe lampate* (*Litsœa khassana*), *gokuldhup* (*Canarium sikkimense*), *tun* (*Cedrela toona*), *malagiri* (*C. ceccidodaphne*), *angare* (*Phœbe hainesiana*), *lali* (*Amoora wallichii*), *panisaj* (*T. myriocarpa*), *halunre tun* (*C. tabularis*) and such others as the Divisional Forest Officer might, from time to time, order to be reserved.

The practice of keeping open the 4-foot lines was stopped as it was found that they formed convenient elephant paths. Sowing and planting in blanks was also prescribed for areas where no seedlings of valuable species were found.

The second plan remained in force until 1924 when the third plan was prepared by Mr. J. M. Cowan, Deputy Conservator of Forests. By this time the whole of the flat land had been worked over and regeneration had been assisted by sowing in lines, broadcasting, burning and *taungya*. Mr. Cowan in describing the forest stated:—

"(1) On loamy clay the predominating species are *panisaj*, *lampate*, *lali*, *malagiri*, *champ*, *bhadrase* and *mandane*, while in moist places there are groups of almost pure *nageswari* (*Mesua ferrea*). Canes are found along the banks of the shallow streams.

(2) On rocky soil the principal species are *odal*, *mainakath* and small groups of pure *lampate* with an enormous undergrowth of creepers. Scattered *sissu* trees are found in well drained areas and in the sandy beds of the Neora and Chel rivers.

The area was jhumed in former years and has now been completely coppice felled. Part has been artificially regenerated with *panisaj*, *mandane*, *toon* and *champ*. Coppice shoots have flourished in class (1) forests. In class (2) they have been badly suppressed by creepers."

Again a 20-year rotation was fixed, but the method of executing the fellings was made dependent on the steps which could be taken to regenerate the area. The prescriptions were:—

"As far as possible *taungya* cultivation should be arranged. Areas for which cultivators are available will be clear felled, burnt and sown with fast growing species suitable for timber and box

planking. Where labour for cultivation is not available, areas which can be sown broadcast will be cleared and burnt. The broadcast sowings must be dense. Other areas will not be burnt and trees of the following species will not be felled:—*Sal, simal, ghamar, mainakath, gokul, panisaj, champ, odal, halunre, mandane, toon, nageswari, kadam, chikrassi, gokuldhup, kainjal, dalchiwari, sissu, karri, lali, lampate, malagiri,* except those which are badly shaped, diseased or dying, or which will be overmature within a 20-year felling period."

In about 1931-32 it was realized that the areas that had been regenerated by *taungya* had been sown and planted with species that would be too valuable to fell for firewood on a 20-year rotation and correction slips were issued which modified Cowan's prescriptions to some extent.

Instead of the whole forest being worked under a short rotation it was decided that part would continue to be worked under Cowan's prescriptions and part would be worked for timber under a longer rotation. The areas which already carried plantations of valuable species were, as far as possible, excluded from the short rotation, although for convenience of working it was not found possible to exclude all of these areas.

As it was no longer necessary to provide timber from the areas to be worked under the short rotation, experiments were made with plantations of quick growing species which would give a large outturn of fuel in as short a time as possible.

In 1933-34 Cowan's plan came up for revision and it was decided that, in view of experience gained, it would be better to have a new plan and consequently the fourth plan was prepared by Mr. N. Pal, Deputy Conservator of Forests.

The natural crop at this time is described:—

"The entire crop consists of coppice with standards of the mixed dry type. In the portion between the Minglass-Gorubathan road and the Mal *nadi* and in the northern half of the portion between the Mal *nadi* and the Neora river the coppice growth is of first quality. The soil is loamy clay and *panisaj, lampate, lali, malagiri, champ, toon, bhadrase* and *mandane* predominate amongst the standards. *Nageswari* occurs almost in pure patches on damp soil in Compartment 13. Canes are found along the banks of *jhoras.*

In the rest of the block the soil is stony and shallow, the coppice is poor and has, in places, been completely ousted by an enormous growth of creepers. *Udal, mainakath, lampate* predominate as standards. Scattered *sissu* and *siris* are found along the banks of the Chel and Neora rivers. *Khair* is found on new formations in the bed of the Chel river."

In 1934 the area consisted of—

4,274 acres of coppice with standards.

85 acres of old forest on the ridge above the Mal *khola*.

1,475 acres of plantations.

255 acres of river bed, 15 acres of rocky blanks and 3 acres of building sites.

Of the coppice, 1,500 acres in the Minglass felling series (Compartments 8, 9, 10 and 11), *i.e.*, the area lying to the west of the Minglass-Gorubathan Public Works Department road are of no value, consisting of practically nothing but a tangled mass of climbers with a few standards.

It will be seen, therefore, that great progress had been made and the crop vastly improved.

In the fourth plan, Cowan's prescriptions, as modified by correction slips in 1933, were retained with some further re-allotment of the area to the long and short rotations. As a large part of the area allotted to the long rotation consisted of nothing but a tangled mass of climbers it was prescribed that, in addition to the area to be cleared and replanted with timber species, a further area should, if labour permitted, be cleared and planted up with fast growing species suitable for fuel, to ensure that when the time came for these areas to be cleared for re-planting with timber species there would at least be some utilisable outturn as well as improvement in the soil.

For the areas to be worked under the short rotation the prescriptions were very much the same as under the third plan, except that no standards were to be retained in any coupe and all coupes were to be burnt. Experience showed that areas that were cleared and burnt came up with a dense crop of *siltimur* (*Litsœa citrata*), *kuel* (*Trema orientalis*) and *mallata*, and that climbers were, to some extent, reduced by the burn. As it was found impossible to protect standards from the fire they were killed, if left, and as timber is to be

provided from the areas under the long rotation, there was no object in retaining them.

The rotation was fixed at 20 years although it was realised that a revision of the rotation might be necessary in the future. It was noticed that *siltimur, kuel* and *mallata* started to die out from about the seventh year and it was doubtful if the coupes which carry an almost pure crop of these species would last for 20 years. It was prescribed therefore that any coupe in which these species were seen to be dying back should be felled and the prescriptions of the plan held up until they had been worked over.

Experiments with other fast growing species have been continued and it seems that *lampate, mandane, Albizzia* spp. and *kadam* will probably give the best results. It seems probable that in the future a rotation of from 10 to 15 years will be sufficient for the production of useful fuel but it is too early yet to come to any definite conclusion. Experiments are being continued as to the most suitable species and efforts are being made to increase the labour force, as it is apparent that fuel *taungyas* promise to yield a bigger outturn of more valuable fuel than the coppice coupes.

Climber cutting.—In all of the working plans the damage done by climbers was recognised and in each prescriptions were laid down for this essential operation. In each plan there is a note to the effect that owing to shortage of funds and the difficulty of obtaining labour the prescriptions of previous plans have not been carried out fully and that the work has not been done properly.

Unfortunately funds for climber cutting are still scarce but every pice that can be scraped together is now earmarked for expenditure on coppice coupes. If climbers can be cut at frequent intervals, not only will a better price be obtained for the produce but making plantations, or regenerating fuel fellings, will be considerably less difficult and the Mal Block will lose its unenviable reputation.—*(Extracted from the Proceedings of the Indian Forest Service Officers' Conference at Darjeeling, 27th September to 2nd October, 1937.)*

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for June 1938 :

IMPORTS

ARTICLES	MONTH OF JUNE					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
Siam ..	70	..	115	9,996	..	22,469
Burma ..	..	15,143	11,471	..	18,65,282	15,75,712
French Indo-China	76	92	6	8,902	10,333	1,059
Java .	..	85	203	..	7,292	24,517
Other countries ..	..	..	22	..	..	803
Total ..	146	15,320	11,817	18,898	18,82,907	16,24,563
Other than Teak—						
Softwoods ..	815	1,969	952	45,524	1,48,580	74,876
Matchwoods ..	813	1,380	1,281	40,243	82,810	89,871
Unspecified (value)	..	..	..	24,007	2,04,894	2,19,077
Firewood ..	20	36	62	316	540	930
Sandalwood ..	23	10	..	8,054	5,283	149
Total value ..	..	..	..	1,18,144	4,42,107	3,84,903
Total value of Wood and Timber ..	..	..	..	1,37,042	23,25,014	20,09,466
Manufactures of Wood and Timber—						
Furniture and cabinetware ..	No data			No data		
Sleepers of wood ..	..	..	32	..	..	4,366
Plywood ..	284	502	766	62,037	1,11,525	1,50,498
Other manufactures of wood (value) ..	..	..	..	1,29,510	1,47,976	1,34,344
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	1,91,547	2,59,501	2,89,208
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	26,821	24,756	17,044	1,65,273	2,05,206	1,87,686

EXPORTS

ARTICLES	MONTH OF JUNE					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	2,515	2	..	5,12,620	520	..
,, Germany ..	401	..	..	99,678	..	..
,, Iraq ..	51	7	3	6,350	1,422	835
,, Ceylon ..	..	..	..	..	..	..
,, Union of South Africa ..	826	..	..	1,75,293	..	..
,, Portuguese East Africa ..	167	..	..	28,422	..	..
,, United States of America ..	23	..	..	5,556	..	..
,, Other countries	1,421	72	115	3,03,145	19,540	50,162
Total ..	5,404	81	118	11,31,064	21,482	50,997
Teak keys (tons) ..	383	..	..	57,525	..	..
Hardwoods other than teak ..	130	..	..	15,011	..	..
Unspecified (value)	..	..	..	20,628	1,03,893	9,622
Firewood ..	..	..	..	..	..	..
Total value ..	..	..	..	93,164	1,03,893	9,622
Sandalwood—						
To United Kingdom	..	..	1	..	..	575
,, Japan ..	5	..	..	6,000	..	..
,, United States of America ..	52	107	50	51,600	1,08,000	50,000
,, Other countries	6	35	5	8,202	35,919	4,900
Total ..	63	142	56	65,802	1,43,919	55,275
Total value of Wood and Timber ..	..	..	..	12,90,030	2,69,294	1,15,894
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	6,320	22,957	46,607
Other Products of Wood and Timber	No data			No data		

BRANCHING AND SEED ORIGIN IN COORG TEAK PLANTATIONS

By M. V. Laurie, M.A., I.F.S.

Central Silviculturist, F. R. I.

Abstract.—Four different types of branching seen in Coorg teak plantations are described and illustrated and the probability of their being due to hereditary factors discussed. It appears that varieties arising from seeds from dry localities may have considerably exaggerated characteristics when raised in damper and more favourable conditions. The necessity for ascertaining that the seed comes from a good origin when making teak plantations is emphasized.

The publications on the subject of seed origin, and the experimental work that has been done so far have tended to emphasise the search for desirable characteristics and faster growth rather than the avoidance of abnormally bad growth forms. Yet it would appear that the latter is more frequently of importance and that the number of plantations that have been raised of trees of exceptionally poor growth form is considerable.

the United States of America alone.* The present crisis has, therefore, offered once again a good opportunity to the Indian product to establish itself in the markets of the world and every effort should be made to establish and maintain a permanent trade, even when the conditions return to normal. Already the market has become easier, China having sold 105,000 lbs. in May to the U.S.A., and prices for ephedrine hydrochloride have fallen to 8s.—9s. per oz. According to the Report of the Imperial Institute, another cause contributory to the present lowering of prices is the introduction of large quantities of synthetic ephedrine hydrochloride, complying with all the B. P. specifications, including optical activity. It may be mentioned here that synthetic products are ordinarily optically inactive and in medicine optically active natural product is generally given the preference. The current high prices of ephedrine hydrochloride have induced the manufacturers to go to the length of producing optically active preparations thus making it identical in every respect to the natural product. The competition from synthetics, however, is not likely to be acute, because the cost of production is at present much higher than the normal price for the natural product, *i.e.*, 4s. to 5s. per oz.

It is evident that the present prices for Ephedra are unlikely to be maintained and Indian Ephedra will sooner or later have to meet competition, if not from the synthetic product, at least from the Spanish and Chinese species. At present, the prices offered

*Country.	January 1938.		February 1938.		March 1938.		April 1938.		May 1938.	
	lb.	$	lb.	$	lb.	$	lb.	$	lb	$
China ..	24,400	1,699	12,897	909	45,142	3,372	3,565	286	1,05,584	7,861
Japan ..	19,784	1,022	30,400	2,118	42,534	2,702	..	..	14,400	1,030
India ..	..	..	..	..	176,155	12,420	1,93,970	11,649	76,225	5,128
Spain ..	..	..	..	..	..	..	..	..	9,485	555
TOTAL ..	44,184	2,721	43,293	3,027	2,63,831	18,994	1,97,535	11,935	2,05,694	14,563

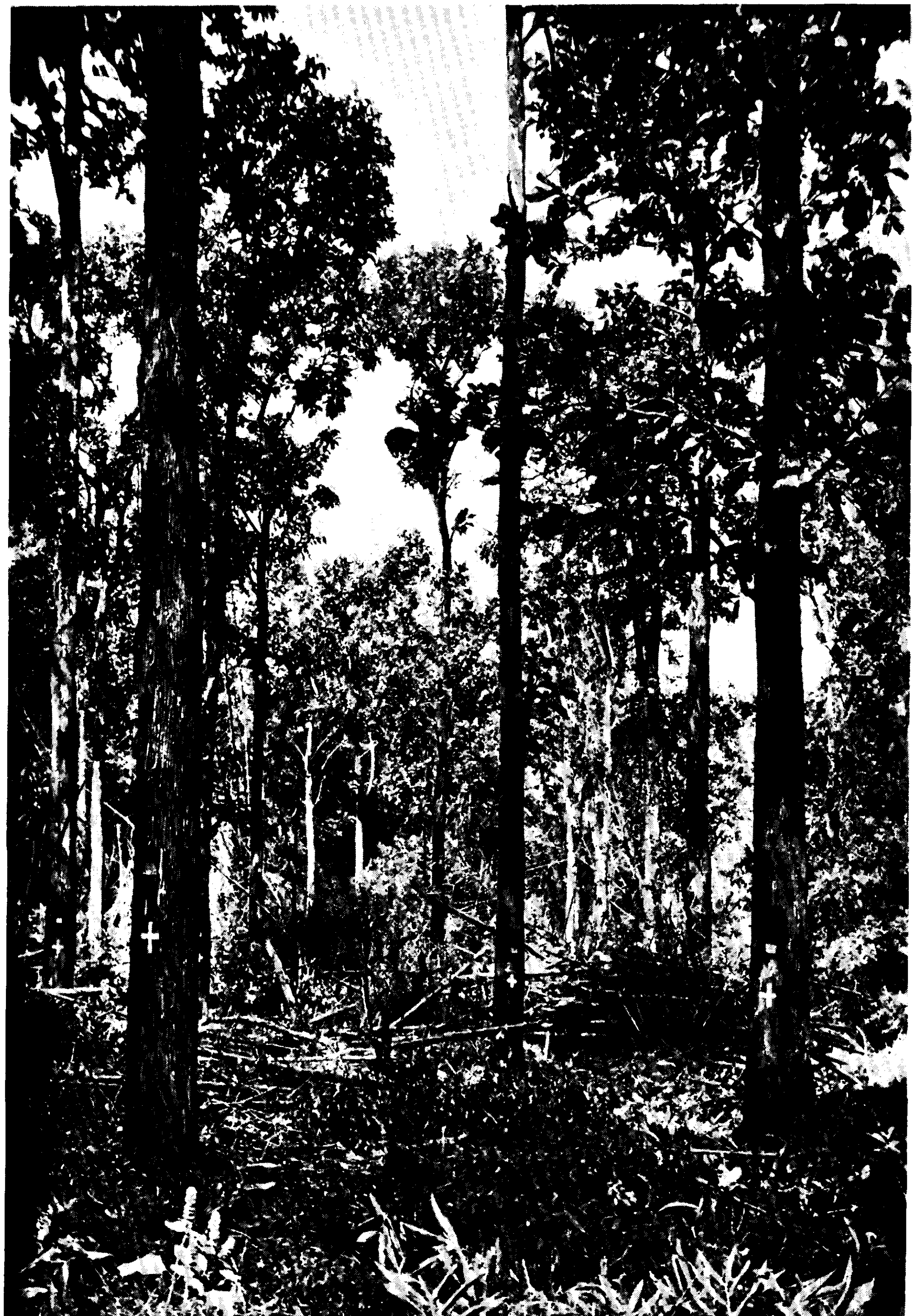


Fig. 1.—Clean, straight, well grown unbranched teak in oldest plantations in Coorg.

Karmad plantation, 1868—71,
S. Coorg.

Photo: M. V. Laurie,
29th Nov. 1937.

Fig. 2.—Branching Type A in teak plantations.—the "Big Bad Wolf" Type. The side branches are thicker and more vigorous than the leader, and the tree occupies the space of several normal trees. Tree is only 5 years old.

Mallipatna 1932 plantation, S. Coorg.

Photo: M. V. Laurie, 27th Nov. 1937.

Anyone visiting the teak plantations in Coorg for the first time cannot fail to be impressed by the excessive branchiness in most of them. One or two of the older plantations, *e.g.*, Karmad, 1868--71, have very fine tree form that will stand comparison with the best plantations in India (Fig. 1), but the later plantations are in many cases so badly branched that the value of the timber, they will produce, will be low. Observations in these plantations indicate several distinct types of persistent branching and forking. As one walks through a plantation or drives past one in a car it is easy to recognise these types. They are so strikingly distinct that once noticed they cannot be mistaken.

I have, for purposes of reference, classified these types as follows:

Type A.—The "Big Bad Wolf" Type ("B.B.B. for short if the more picturesque Central Provinces term *Bhalu* or Bear is used instead of Wolf"). This growth type is not very common and was only encountered on two occasions. In each case there were two or three of these trees growing near each other. Fig. 2 shows what they are like. The leader is weak but general growth is abnormally vigorous—so much so that one tree of this type may occupy the space of 4 or 5 normal trees, and suppresses all those with which it comes in competition. Its height growth is not noticeably greater than normal trees of the same age, but lateral growth is exceedingly strong. This type of branching, unlike those which will be described below, shows up in young trees only three or four years old. It is obviously a monstrosity, and it would be very interesting to find out whether it is a polyploid form, or a mutation, or whether its abnormal character is due simply to the chance combination of different sets of characters in the parent trees. It has, to the eye, all the aggressive vigour of a polyploid.

From a practical plantation point of view, the form is not common enough to be important, but when it does appear, it causes a considerable amount of damage by suppression of neighbouring trees and is itself useful only for firewood.

Type B.—Horizontal Branching Type (Fig. 3).—In this type persistant horizontal branches, in fairly widely spaced false whorls, are characteristic. The whorls appear to be spaced apart by about a year's growth on the main stem, though this was not verified. This type of branching occurs in contiguous lines or groups of trees of

varying extent. Their distribution strongly suggests that the trees came out of the same bag of seed. The branching is very distinctive and was seen in both dense and open plantations, and appears to persist independently of density and past thinning practice. The trees have a normally strong leader and a straight main bole, but the timber will have whorls of very large knots running right into the core every two to four feet.

Type C.—Vertical Parallel Branching Type (*Fig.* 4).—This is a very distinctive and striking type, and is characterised by a weak leader and strong upward tending branches, mostly lying in a single lateral plane. Its distribution is similar to that of Type B, and again suggests that the seed of these trees came out of the same bag. Congestion or crown freedom does not appear to affect the occurrence of this type of branching. Such trees will, of course, only give short lengths of straight timber and the value of the tree is greatly reduced.

Both the character and the distribution of types B and C strongly suggest that these branching types may be hereditary.

Type D.—The "Candelabra Type" (*Fig.* 5).—This is not well named, but is so called for want of a better name at the moment. This is quite the commonest and most serious type of branching in Coorg and has spoilt many whole plantations. It appears to be due to a weakened leader dying on account of some adverse circumstances such as possibly drought, or more probably defoliation, response taking place later by the production of between 2 and 10 shoots (usually 2 to 4) which grow outwards to start with and then curve upwards. It is most noticeable that a plantation may grow quite straight for a number of years and then throughout almost the whole plantation at about the same height this branching occurs, *e.g.*, 1912 to 1923 Malalaikatti plantations and 1916 Reshmegundi plantation,—the latter being an especially striking example. In some cases the branching is repeated again higher up the tree, which, of course, ruins it from the timber production point of view.

In the past, this type of branching was attributed to underthinning followed by opening up weakened crowns, but this is almost certainly not the case. It seems probable that the immediate cause is, as already suggested, some adverse circumstance such as defoliation

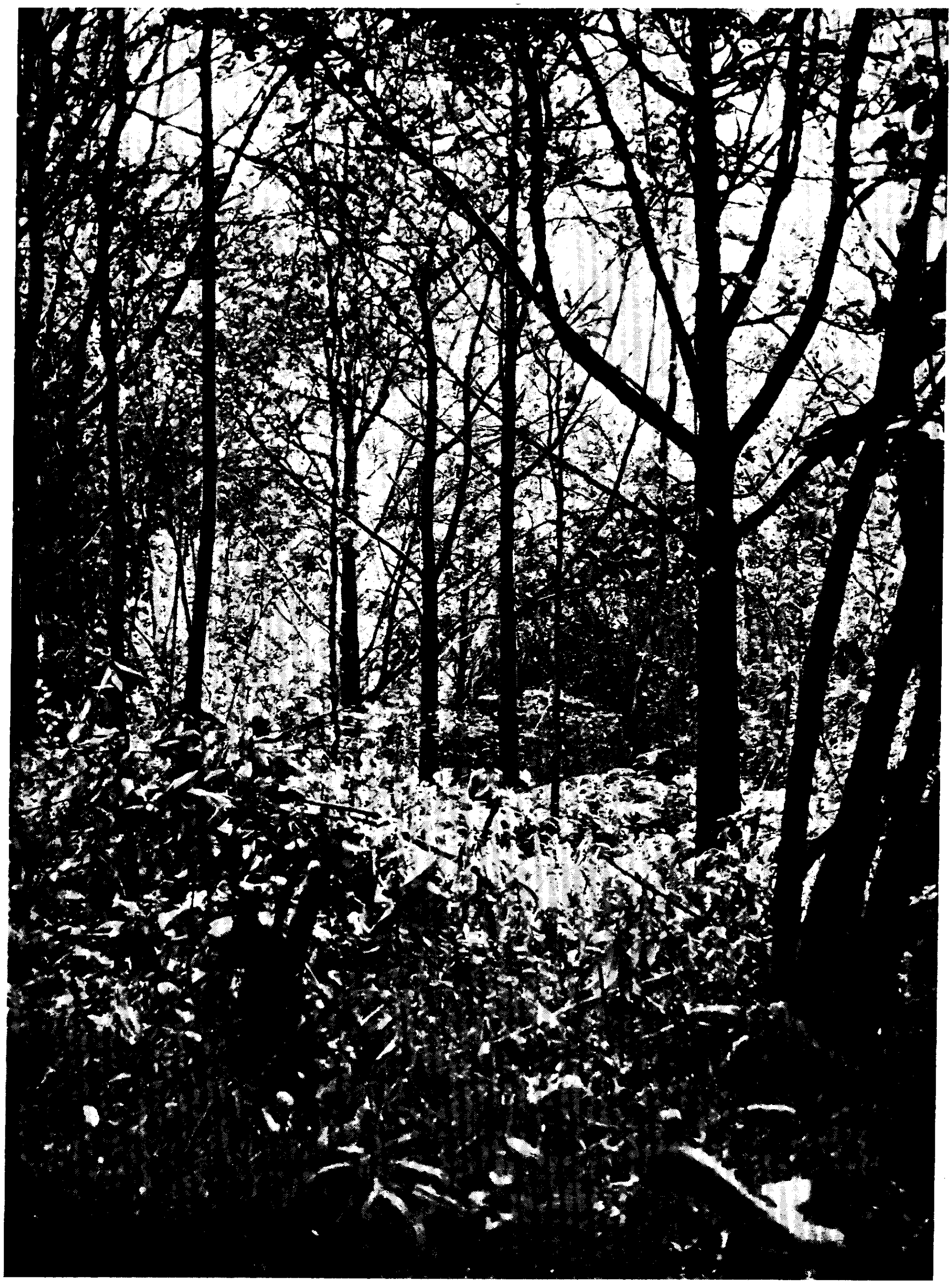


Fig. 3.—Branching Type B.—Wide, horizontal, persistent branches in false whorls. Groups or lines of trees of this type are found together. Small normal unbranched tree on the left.

Gonigadde—1903 *teak plantation, S. Coorg.*

Photo: M. V. Laurie, 28th Nov. 1937.

Fig. 4.—Branching Type C.—Vertical, parallel branching, with most of the branches lying in a single lateral plane. Groups or lines of these trees are found together suggesting a common parent tree.

Gonigadde—1907 *teak plantation.*
S. Coorg.

Photo: *M. V. Laurie,*
28th Nov. 1937.

Fig. 5.—Branching Type D.—Candelabra type, due to failure of the leading shoot resulting in a rosette of branches. Nearly every tree in the picture has this type of branching. Some have it repeated at different levels (*e.g.*, tree on right of picture). Vestiges of dead leading shoots visible in some.

Devamachi—1923 teak plantation, S. Coorg.

Photo: *M. V. Laurie.* 11*th Nov.* 1937.

or drought. The fact remains, however, that some plantations in the same localities escape altogether and produce good straight unbranched timber. These are mostly the earlier plantations.

The seed supplies for the oldest plantations in Coorg, when planting only took place on a very small scale, were very probably of local origin, though definite records are not forthcoming. When planting operations later extended into several hundreds of acres a year, local supplies were not sufficient, and seed was obtained from Mysore State adjoining. Here teak is mostly of a much drier, branchier type. Good teak is practically confined to the S.W. corner of the State (Kakankoti) adjoining the Wynaad Division of Madras, but all the seed from this was required by Mysore State itself for their own plantations. Since Coorg made no specifications about the origin of the seed they received, naturally they got the most easily collected seed from the dry forests that was not wanted by Mysore for their own planting work. It is suggested that as a result of growing this dry type seed in a damper, more luxuriant environment in Coorg, hereditary branching tendencies (A, B and C) might tend to appear in extreme forms while in the case of D, slight hereditary weakness of the leading shoot (not as extreme as in A or C) might be the cause of the extensive branching of type D occurring after adverse conditions.

It is, of course, not definitely proved that these branching tendencies are hereditary, but the evidence is so striking to the eye that one does not hesitate to say that it is a probability rather than a possibilty. It is safer, therefore, to assume that this is so, and to guard against the chance of wasting money in growing badly formed trees that will have very little timber value by obtaining seed from a locality where the teak is known to be straight and well formed. The local trees in Coorg are mostly of good form and it is probable that plantations raised from local seed would be considerably cleaner than many of those raised from imported Mysore seed.

The teak seed origin experiments now in progress in many places throughout India will, it is hoped, give valuable evidence regarding the localities which produce hereditarily the straightest, cleanest timber. It is suggested that similar plots might also be laid out in Coorg with seed from different recorded origins to

demonstrate to future generations of forest officers what sources of seeds are acceptable and what are to be avoided.

With the possible exception of A, the typical branching of forms B, C and D does not appear until the trees have developed their adult crown form, *i.e.*, when the plantations are six years old or more (usually considerably more). It is possible, therefore, to raise plantations successfully from seed of the worst hereditary tendencies without realising that anything is wrong. One's successor has to carry the baby when the plantations start branching right and left and turn from straight young hopefuls into branchy rubbish.

THE VEGETATION OF THE NILGIRIS

By N. L. Bor, I.F.S.

Mr. Ranganathan has written an extremely interesting account of the vegetation of the Nilgiri plateau (published in the September number of the *Indian Forester*), and has put forward a novel theory to account for the extensive rolling downs of grassland, interspersed with patches of evergreen forest, locally known as *sholas*, which are such a feature of the landscape.

As the author himself admits, it is difficult to reconcile his theory, namely, that in a given climate, two climatic climaxes of such widely divergent life forms, grassland and forest, can exist in harmony with the current views on vegetation as accepted by most ecologists.

Now, with regard to climaxes, I do not propose, in this paper, to discuss the merits or demerits of any particular school of thought, but will merely mention two that, to my mind, are worthy of consideration.

Clements and his adherents admit of no other climax than that which is the culmination of a sere and which is determined by the climatic factors alone. All other communities, even those which, by reason of firing, grazing and so on, simulate a climax, are considered to be proclimaxes and not true climaxes. The argument being that once the unfavourable factor, which has caused succession-retardation, is removed, the progression towards the climax is resumed.

Tansley and his school, on the other hand, assert that there may be many climaxes, such as edaphic, biotic and so on. Tansley makes

a distinction between *autogenic* and *allogenic* factors. He says the *autogenic* factors, that is, the reactions and coactions of the vegetation upon itself and its habitat lead to the climatic climax, while the *allogenic* factors, fire, grazing, soil difference and so on, lead to the biotic, edaphic, etc., climaxes.

Now whatever terminology one adopts, it is clear that the term climatic climax cannot be applied to two communities in which the factors controlling the vegetation are not the same. On the one hand we have the grassland governed by climate, burning and grazing, and on the other, forest governed by climatic factors alone.

If one follows the Clementsian terminology and considers the grassland to be a climax (which it obviously cannot be since it is subjected to fire and grazing), then the shola is a post-climax. Alternatively, if the shola is considered to be a climax, then the grassland must be a pro-climax.

According to Tansley, however, the grassland would be considered a biotic climax and the shola a climatic climax.

No one will disagree with Mr. Ranganathan when he says (referring to the grassland): "a plant community which has been in possession of its territory for centuries is entitled to be called a stable association whatever the factors that ensure this stability may be." The factors which ensure this stability, however, are not the same factors as those which ensure the stability of the shola and both communities are obviously of different status.

Apart from terminology, however, which is only a convenient and concise way of giving expression to ecological concepts, Mr. Ranganathan has raised a subject which is of very great interest to plant sociologists, namely:—What is the climax vegetation of the Nilgiris?

The most striking feature of the vegetation of the Nilgiris, as a whole, is that there is no tension belt or ecotone between these mutually hostile communities of grassland and forest. The grassland and the shola forest seem to be absolutely distinct and the boundary between them is clear-cut.

The first point to be determined is whether the climatic factors, leaving the edaphic and biotic factors aside for the moment, are such as to constitute a forest climate or a grassland climate.

According to Von Faber (1935, pp. 278—282), a good forest climate consists of the following elements: A constantly moist subsoil so that the loss of water through transpiration can be reduced. Warmth during the vegetative period with little wind at the time of water shortage. It is unimportant whether the soil moisture comes from precipitation or from underground sources, whether the precipitations are frequent or few, or whether they fall during the active or resting period.

As far as the grassland is concerned, a good climate would be one in which frequent precipitations, even though small, take place during the vegetative period accompanied by sufficient warmth.

Mr. Ranganathan admits that the climate of the Nilgiris is a forest climate and after reading his account of the climate and the figures given by Champion (1936, p. 213) one must agree with him. The Nilgiris possess a well distributed rainfall with no marked dry period, though in January and February the average precipitation is less than one inch. The number of rainy days in twelve months is at least one in four, and the humidity high for the greater part of the year.

A forest climate ends in the victory of the forest but it is contended that the forest cannot develop by reason of the ground frosts which are particularly severe in the early part of the year. Ground frosts have not, however, prevented forest being developed in a forest climate in other parts of the world in the tropics.

Apart from climate the activities of man exert a profound effect upon vegetation. The inhabitants of these rolling downs are the Todas, a primitive people who are purely pastoral and do no cultivation whatever. All their requirements in grain are obtained from their neighbours, the Badegas. As the author states in his paper, they are not axemen and cannot be held responsible for clearings of any extent. It is true that the present-day Toda does not practise shifting cultivation but he does use wood, and a good many of the shola species have a peculiar significance in his ritual ceremonies. The influence he exerts at any one time may only be small but it is cumulative when one considers how slowly the shola regenerates itself even in favourable localities.

The first occasion on which contact was made with the Todas by a European was in 1602, when a Portuguese priest, Finicio, succeeded in penetrating the hills and wrote an account of his journey. His manuscript is still preserved in the British Museum.

From his account it is certain that the relations between the Badegas and the Todas and the appearance of the landscape were very much the same in 1602 as they are to-day.

The origin of this people is wrapped in mystery but according to Rivers (1906), who made a study of the tribe, it is possible that they originally came from Malabar. If this is so, his conclusions are not mere speculation, and assuming that the Todas have always been pastoral, which is unlikely, it is at least possible that the earliest inhabitants were not pastoral but made clearings for their habitations and cultivation like all other primitive peoples.

At any rate, Rivers assumes that the Todas followed an earlier people who have left traces of their culture behind in the cairns on the hills; places for which the Todas at the present day have no reverence, and although no agricultural implements were found in the cairns, that does not prove that the people who built them did not practise some form of cultivation.

Whatever may be the ancient history of the Todas, it is perfectly clear that they have been in possession of the territory they occupy to-day for a very long period of time; at any rate, well over 300 years. During all these centuries, they have maintained herds of buffaloes and have grazed their territory to its limit. They fire the grass stubble, when it is dry enough to burn, in order to obtain the first flush of grass as early as possible. When grass is not sufficient the buffaloes are taken to places where grass is still to be got. Two customs of the Todas, infanticide and polyandry, the former of which was practised up till comparatively recent times, ensured that the numbers of the tribe were kept within limits and it is possible that the Toda population has been comparatively static for ages. This accounts for the fact that the Todas have not spread over the plateau but have been content with the area of grassland available.

It can be taken, therefore, as extremely probable that the grassland, however it arose, has remained in the same condition for centuries. But is it really stable?

Grave doubts of the stability of the grassland arise when one reads the paragraph entitled "Invasive plants of the grassland." We read that certain indigenous plants as well as *Eupatorium glandulosum, Ulex europaeus* and *Cytisus scoparius*, all of them exotics, have made considerable inroads into the grassland in recent years, so much so that the residents of Ootacamund consider that the beauty of the downs is in danger of being completely ruined.

If this argument is pushed to its logical limit, one can pertinently ask, I think: What is going to be the dominant community of the downs if the spread of these exotics is not checked? Is the grassland, which Mr. Ranganathan considers to be a climatic climax, about to give way to another community of higher life form, without a change in climate? If fire and grazing cannot hold the exotics at bay, it looks extremely likely as if they are going to defeat the grass. At any rate, it will be admitted that what is actually happening looks singularly like progression.

It will be argued, of course, that these invading species are exotics and the fact that they are ousting grassland proves nothing. While it does not prove that the shola is a climatic climax it does prove that the grassland is not a climatic climax.

As far as is known, no climatic climax has ever been ousted by an exotic, the climatic and edaphic factors remaining the same, unless helped by the hand of man. On the other hand, a seral community replaced by a gregarious exotic is no new phenomenon. One need only instance the spread of *Eupatorium odoratum* in the grassland of the hills and plains of Assam in recent years. Under normal conditions *Eupatorium* can find no footing in a climax forest.

If the shola is taken to represent the relict of a vast forest which once covered the Nilgiri plateau, a forest which during the course of centuries has disappeared on the more exposed aspects owing to the cumulative effects of cultivation, fire and grazing, I think just as strong a case may be made out for its position to-day as for the assumption that grassland was the original covering. The fact that we are dealing with a climate that is a forest climate makes the former assumption more plausible.

If it be admitted that grassland and forest, which are accepted to be mutually hostile, cannot both be climaxes in the same climate the question naturally arises as to which of the two is the climax.

It is very natural to consider the higher form of vegetation occupying any climatic area to be the climax in that particular climate. Mr. Ranganathan presumes the sholas sites to be the nuclei of shola forests, thereby indirectly assuming that the original vegetation was grassland and that the evergreen has occupied certain sites which are favourable to forest growth simply owing to the configuration of the ground. Now a search for origins, in so far as the vegetation is concerned, is almost as difficult as the search for ultimate realities, because nobody has got the knowledge to trace the history of the plateau. The author of the paper under consideration is on a good wicket if he points out that the shola sites have arisen owing to long continued denudation and have been occupied by migration from the Western Ghat forests. It is easy to disagree with Mr. Ranganathan but a far more difficult task to prove him wrong.

If the climax be grassland, why does not it oust the shola: if it be forest, why does not the forest advance on the grassland?

In the normal course of development, grassland cannot advance upon forest if the climatic factors remain the same. In other parts of the world where a grassland climate gradually changes over a wide area to a forest climate there is also a gradual transition from grassland to bush, and so to forest. There is nothing of the kind in the Nilgiris where grassland and forest exist side by side. The species of the grassland are mostly *andropogonous*, that is, highly developed grasses which cannot exist in shade and therefore can find no footing in a forest. If the forest, however, is weakened and destroyed by fire so that light is admitted, then one can say with certainty that it will be replaced by grass.

The reason why the shola does not retreat before fire lies in the fact that it now exists in its last stronghold. As already stated, it maintains itself on northern aspects in folds of the ground which are cooler and moister, and is mainly found just over the margins of such places. Fire rushing up a ridge burns itself out or is greatly reduced at the top and the moisture conditions of the shola finally call a halt.

Towards the bottom of the shola the soil becomes swampy and fire cannot gain an entrance into the forest.

On the other hand, I think there are very good reasons for the inertia displayed by the shola *vis-á-vis* the grassland. According to Clements, the prime factors influencing the onward march of vegetation are migration, aggregation, ecesis and competition.

Anyone who has read over the list of shola species will have been struck by the fact that the very great majority of them possess drupaceous fruits of one kind or another. In other words, the seeds of these species are not produced in the quantity nor are they of the type which could lead to rapid successful migration or aggregation. With regard to ecesis, which means the adjustment of the plant to its new home, it has already been pointed out that a seeding with any hope of success would have to contend with insolation, frost, fire and grazing: a formidable quartette of inimical factors.

In an evergreen climatic climax, no matter where it is, in the mountains or the plains, the tree species reproduce themselves in a special habitat which is of their own making. There is a humus-impregnated soil which contains a high percentage of moisture, soil and air temperatures are more equable than outside the forest and there is no danger from drought, frost or insolation. The seedlings and young trees are protected from their youth upwards until the time comes for them to take the place of one of the dominants. Throughout their thousands of years of development the shola species have lived this sheltered life and it would be entirely against accumulated experience to expect them to spread into grassland without the protection which is necessary for their growth in the early stages.

Evergreen forest, of which the shola is a typical example, is a very highly developed community. An evergreen forest, however, on destruction, does not return at once to evergreen but only after several stages which are more or lesss well marked. Unless the area destroyed be a small one, there is a period of preparation, a building up of the lost accumulated richness of the soil and a gradual production of conditions in which evergreen species can germinate and live. All this is brought about by a series of stages in which a lowlier form of vegetation is replaced by a higher. Roughly speaking, grass gives

way to deciduous forest, the latter to semi-evergreen, and last of all the true evergreen climax comes into its own. It can easily be seen that unless conditions are normal, the development will be greatly retarded, especially if fire is a factor to be contended with.

Shola destroyed returns to shola on shola sites, at least those with northern aspects, but the shola species do not begin to appear until a cover of non-shola species has become established to give the necessary cover to the seedlings of the shola trees.

At the present time, in the special habitat of the forest margin, where conditions are intermediate between the rigours of the grassland and the favourable factors within the forest, *Eupatorium glandulosum* has succeeded in occupying the soil. The *Eupatorium* undoubtedly helps to exclude fire and grass and goes some way towards producing conditions of which shola species can take advantage. Two shola species, *Eurya japonica* and *Prinsepia utilis*, have already appeared in the *Eupatorium*.

The absence of fringing forest in the area under consideration need, I think, occasion no surprise seeing that man has been at work for many centuries. One would just as reasonably expect to find fringing forest along the margins of the burns in Scotland. Even in similar areas in the tropics, such as in the Khasi and Naga Hills, there is little or no fringing forest.

One point which has not been considered up to the present is the deterioration of the soil due to long continued erosion, burning and grazing. That such factors bring about changes which are unfavourable to the growth of evergreen trees is scarcely open to doubt, and is proved by the fact that it is extremely difficult to get shola species to grow in the open grassland. Many species have been tried in recent years, mostly without result, though some success has been obtained with *Mahonia leschenaultii*. It is extremely problematical, however, if any success will be achieved on a large scale until some attempt is made to reproduce the conditions existing within the shola, either by following the natural succession of destroyed shola to shola or by raising some crop of trees or shrubs which will add humus to the soil and provide the necessary cover.

It is impossible to minimise the effect of fire upon vegetation. In many parts of the world, including the higher altitudes in the

tropics, experience has shown that forest destroyed is replaced by grass and that the grassland can be maintained indefinitely through the agency of fire. It must be realised that it is only necessary to make a small clearing at the foot of a slope and to fire it annually for the forest covering the whole of the slope to disappear in time. This can easily be demonstrated in any hill district where shifting cultivation is practised. On southern and therefore hotter and drier aspects the top of the ridge is the limit of the grass. On northern slopes the forest is pushed back well above the limits of cultivation. All this can happen in an area with over a hundred inches of well distributed rain and could more easily happen in an area of less rainfall especially if firing accompanied by grazing is continued for hundreds of years.

As far as frost is concerned, which Mr. Ranganathan considers to be the controlling factor limiting shola and grassland, it may be noted that the great majority of species of the evergreen trees of the tropics are frost tender in early youth. In fact it may be taken, generally speaking, that the frost hardy species are seral and act as nurses for the species of the climax forest.

No analogy can be drawn between the Nilgiri Plateau and certain parts of the south-western Jura in Switzerland, where frost actually does in certain places—the well known *Frostlöcher*—prevent the growth of trees in a forest climate. These frost holes are trough-like depressions in which the cold air collects and produces temperatures of the order of—29°C. in winter, with frosty nights during ten out of twelve months of the year. This is an example of a microclimate brought about by the configuration of the ground. In the Nilgiris, however, the grass is not confined to the depressions but exists all over the downs while shola forest is often found in places which one would expect to be frost holes.

To sum up, I believe that the shola forest is the relict of an evergreen forest climax which has been pushed back to its last stronghold by fire and grazing. The grassland I consider to be a biotic climax rendered stable by firing and grazing and only one more proof of the stability of grassland under such conditions.

Whether Mr. Ranganathan is right or I am right, or whether in the immortal words of Mr. Mantalini, "both shall be right and

neither wrong, upon my life and soul, oh demmit," this discussion will have served its purpose if it focuses attention upon one of the most interesting ecological problems in India; a problem upon which a great deal more research is necessary before a definite and indisputable answer can be returned.

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FOREST UTILISATION IN FINLAND

By J. N. Sinha, *Bihar Forest Service.*

Abstract.—In few other countries is forest utilisation so perfected as in Finland. Nature has benevolently allied itself with man. Extensive waterways transport logs from forest to mills and thence to ports of shipment almost for nothing. Efficient sawmills and pulp-mills utilise to the fullest extent all that the forest produces.

Finland is a fortunate country. It has timber that will float very easily and ten thousand lakes and rivers to do the floating from remote forests to saw frames. Between sawmills and pulp-mills everything that the forest grows is consumed. There is no problem of the "exploitable size." There is no wastage.

The natural conditions of forestry are very favourable in Finland. It is this circumstance coupled with the way in which the Finnish people have taken advantage of it that has made the forests the corner-stone of this young State's political and economic independence. Forests contribute the bulk of revenue (about 85 per cent. of the total value of exports comes from forest products) and have been mainly instrumental in raising the standard of living and culture to a high level. Without the help of Nature, however, this intense utilisation of forest produce would not be possible specially when population is so sparse (the total area of Finland is 132,000 sq. miles and the population is 3,650,000 or about three-fifths of the population of London). Another happy circumstance is that there is no difficulty in getting excellent natural regeneration of the forests.

Forest appears to be the strongest of all plant communities, for on abandoned land forest begins to grow sooner or later. It is not so in England and the countries on the Mediterranean.

The important species are only three—pine (*Pinus silvestris*), spruce (*Picea excelsa*) and birch (*Betula verrucosa* and *Betula odorata*), forming 48 per cent., 29.6 per cent. and 19.7 per cent. respectively of the total growing stock. The thick pine and spruce logs are sawn in the up-to-date highly efficient sawmills into deals, battens and boards which are exported principally to England and in smaller quantities to other parts of the world. The smaller pine and spruce timber is converted into paper pulp either by mechanical grinding or chemical processes. The waste of sawmills is also consumed in pulp-mills. Most of the pulp is exported to England where it is converted into newsprint and other varieties of paper. Many of the important daily newspapers of England are printed on paper from pulp imported from Finland. In Finland itself a certain quantity of the pulp is worked up into paper but generally the purchasing countries prefer to buy pulp so that their own labour may get the benefit of the extra work involved in converting it into paper. Birch is employed principally in manufacturing plywood and bobbins. As much as 30 per cent. of the world's supply of plywood comes from Finland. The total quantity of plywood exported annually from Finland is 146,000 tons for which six million cubic feet of birch timber is consumed. Large quantities of bobbins are imported by the Bombay and Calcutta mills from Finland. Among minor manufactures may be mentioned toilette paper, paper napkins and paper bags. Matches are produced from aspen (*Populus tremula*). Finally, all wood of little value and all the waste and trimmings that cannot be used otherwise are used as fuel, for all the machinery and even railway engines burn wood fuel.

Finland is neither too hilly nor too flat. It slopes gently towards south and west into the Gulf of Finland and Gulf of Bothnia respectively. Topographically it is divided into five main river basins; accordingly there are five principal floating associations. The Kemi Floating Association and the Kymi Floating Association are among the biggest. These floating associations are organised and worked on co-operative basis. They take charge of logs belonging to companies and individuals and float them down to the mills.

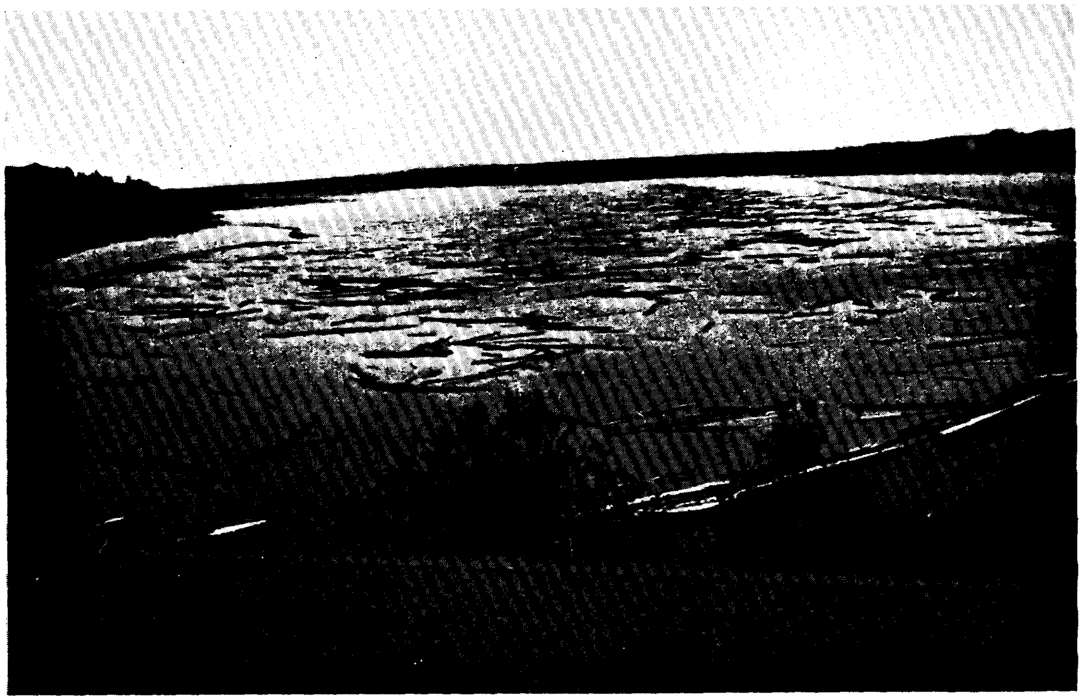

Fig 1.—Timber floating in the Kemi river.

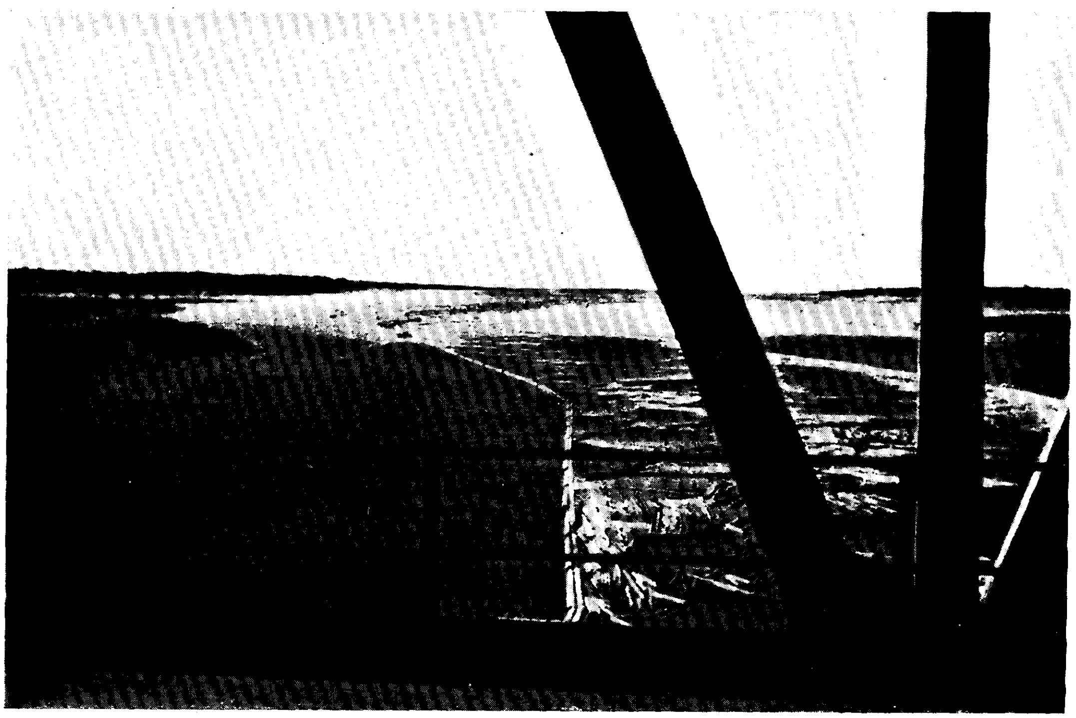

Fig. 2.—Logs in the Kemi river approaching destination.

Photos: J. N. Sinha.

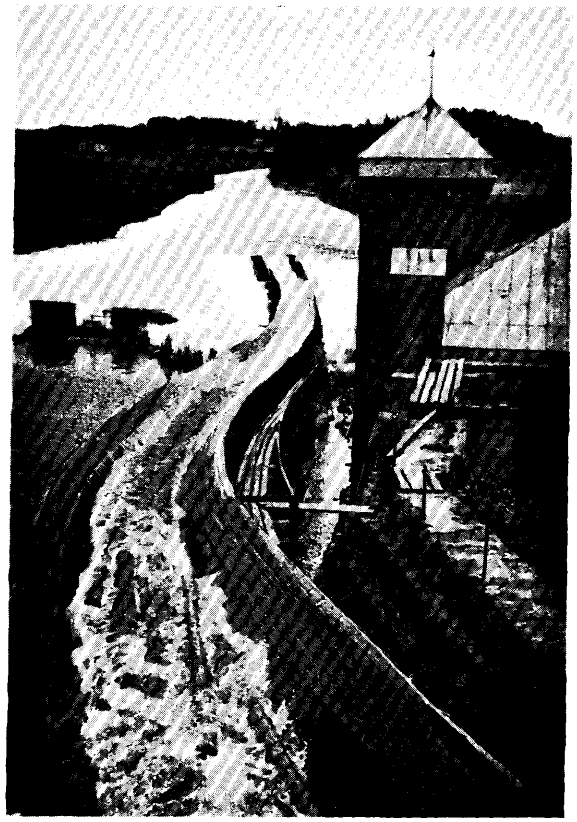

Fig. 3.—Wet flume to negotiate a hydro electric dam at Kotka.

Fig. 4.—Elaborate sorting arrangement near Joensuu. The work goes on continuously day and night.

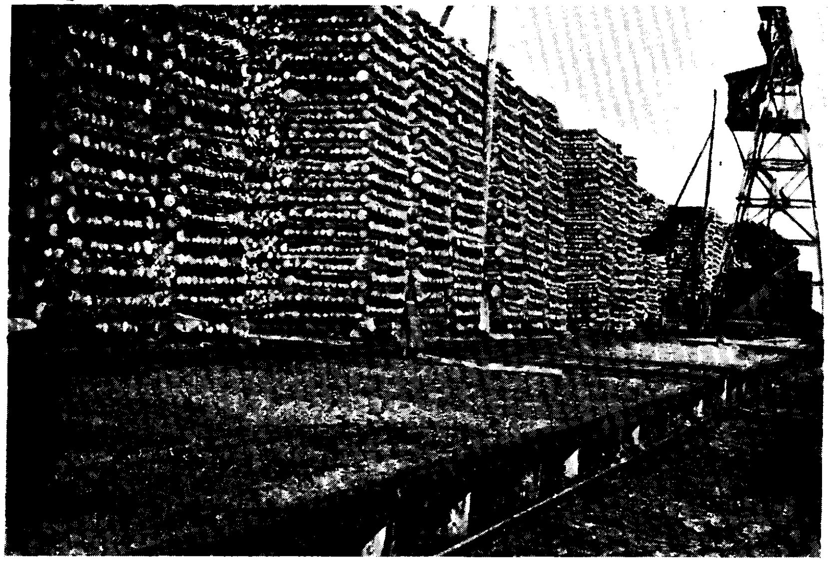

Fig. 5.—Pulp wood stacks—reserve for winter consumption when floating is suspended. Veitsiluoto.

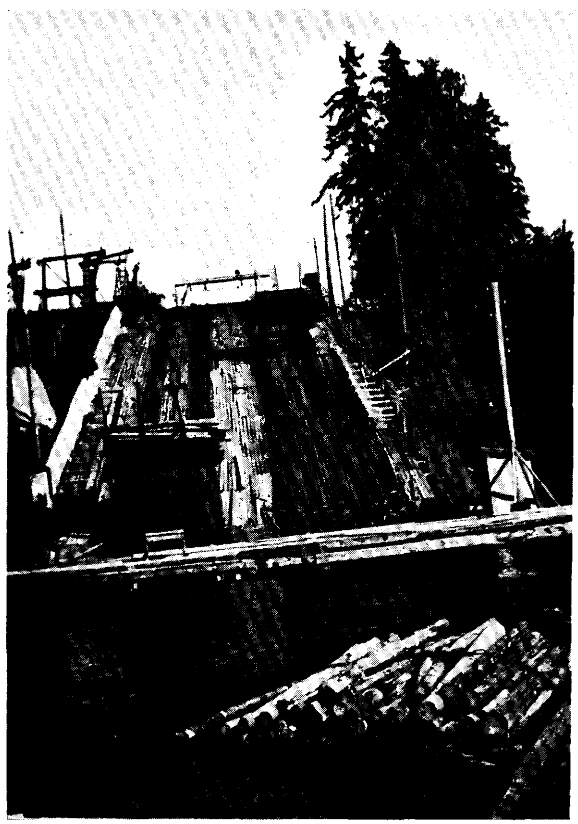

Fig. 6.—Hauling pulp wood in trolley from lake for storage or mill.

At the end of the floating season the cost of floating is worked out. The Kymi Floating Association can float at the rate of one anna for each cubic foot over a distance of 400 miles. It handles 12 million logs per year (one log = 5.3 c.ft. on the average). The Kemi Floating Association floats one cubic foot for three pies over a distance of 600 miles! The average total cost of timber landed at the mill site works out to four to six annas per cubic foot including royalty, handling charges, floating costs, etc.

Logs are transported during winter from the forest to the banks of rivers and streams. Before Christmas the lakes freeze into hard ice and snow fills all ditches and covers all surface obstructions. Thus there are natural roads everywhere. Logs are transported in sledges drawn by horses. These logs, all branded with distinctive owner mark, wait at the banks of rivers until the snow thaws when the rivers run and carry their charge to distant places. At the destination logs are sorted out according to owners. As a large number of owners are generally involved, this sorting arrangement is very elaborate. The floating season lasts from May to November. When lakes intervene in the floating course logs are bundled and hauled across the lakes by steam tugs. Some of the rivers have several dangerous rapids in them. It has needed years of work and money to tame these rapids and make them safe for floating. We negotiated a typical rapid between Vaala and Oulu. It looked very dangerous but by the gradual removal of rocks it has become safe enough.

Uuras, a shipping port in Finland, is said to be the biggest timber shipping port of the world. Eight hundred to 900 ships are loaded per year. One ship carries 1,500 "standards" (one "standard" equals 165 cubic feet of timber). The total annual export of timber from Uuras alone equals 210 million cubic feet.

The mills in Finland are very efficient. At Veitsiluoto we saw 40 different sizes of scantlings being sawn and sorted out by an automatic machine—there was just one man to press the button and the different sizes travelled suspended to varying distances and fell in their own size enclosures, much like the mould letters in a linotype machine.

TIGER CENSUS

By C. M. Chaudhri, I. F. S.

Abstract.—A tiger census—first of its kind—was carried out by Mr. J. W. Nicholson, I.F.S., in 1934, when he was the Divisional Forest Officer, Palamau division. A report of the census appeared in the "Indian Forester" of September 1934. In 1936 I carried out a second census over the whole division and the results are given in this article, as also the results of the third census held in 1938.

In case of human beings a census is carried out by counting the heads at a fixed time on a fixed date over the whole area covered by the census. This direct method cannot of course be adopted in case of tigers and so an indirect method had to be devised. A tiger must drink at least once in 24 hours and advantage is taken of this fact to carry out the census. Based on this fact Mr. Nicholson carried out the first census of this kind in 1934. The method may not be quite accurate but it may be taken to be fairly reliable. It is, however, to be remembered that within limits a tiger does a fair amount of roaming about and as the reserved forests are not detached blocks but adjoin zamindari forests it is a question of chance whether a particular animal is in reserve or zamindari forest on the day of census.

To be successful an attempt of this sort can obviously only be carried out under hot weather conditions when water is scarce. The year 1936 being fairly dry, I decided upon a tiger census and fixed the 1st of May for the purpose. It was repeated in 1938. The procedure adopted was this: In April, all the water holes were searched out and those with perennial streams were marked on a map. In case of streams places where tigers drink are usually well known. Red skeleton circles were used to indicate the water holes and places where tiger usually drank at a stream. On the afternoon of 30th April all the places were visited and all old marks were rubbed out. The places were visited again in the early morning on 1st May. The men who visited the water holes came and reported what holes were visited by tigers in the night. They were required to give the sex of the animal (it is possible to tell, with a fair degree of accuracy the sex of the animal from the pug marks), the direction from which it had come and the direction to which it had gone. The information was marked on the maps, the hollow circles being filled in, in case of water holes visited by tigers and the direction was shown by arrows. In addition, the men had to bring sticks showing the

width of the pug marks. These details were necessary to guard against the same animal being counted at two water holes; it may be mentioned, however, that so far as could be ascertained no animal visited more than one water hole. The results of the enumerations are given below:

Size of pug marks in inches.	MALE.				FEMALE.				BARASAND, 1934.	
	Palamau.		*Kodarma.*		*Palamau.*		*Kodarma.*			
	1936.	1938.	1936.	1938.	1936.	1938.	1936.	1938.	Male.	Female.
11 ..	..	..	..	1	..	..	..	..	..	..
9 ..	..	..	..	2	..	..	..	..	..	..
8 ..	1	..	..	..	..	..	..	1	..	..
7¾ ..	2	..	..	..	..	..	..	..	..	..
7½ ..	2	..	..	..	..	..	..	1	..	..
7¼ ..	2	..	..	..	..	..	1	..	..	..
7 ..	2	5	1	3	..	1	1	1	3	..
6¾ ..	..	..	..	..	..	..	..	..	1	..
6½ ..	6	3	..	..	1	..	..	..	3	..
6¼ ..	..	..	..	..	..	..	..	..	4	1
6 ..	8	8	1	..	1	..	1	1	3	..
5¾ ..	1	..	..	..	2	..	..	..	..	..
5½ ..	..	..	..	..	4	5	..	..	3	..
5¼ ..	1	..	..	..	2	..	..	..	1	1
5 ..	1	1	..	..	3	1	..	..	1	1
4¾ ..	..	..	..	..	..	..	..	..	..	2
4½ ..	..	2	..	..	2	2	..	..	..	2
4¼ ..	1	..	..	..	1	..	..	..	1	1
4 ..	..	..	..	..	1	..	..	..	1	..
3½ ..	2	..	..	..	..	1	..	..	1	..
2¾ ..	..	..	..	..	..	..	..	..	..	1
2½ ..	..	..	..	..	..	..	..	..	..	1
2 ..	..	..	..	..	1	..	..	..	..	..
Total ..	29	19	2	6	18	10	3	4	22	10

Classified according to ranges, the figures for the three years are as follows:

Names of Ranges.	1934. Males.	Female.	Total.	Av. beat, sq. miles.	1936. Male.	Female.	Total.	Av. beat, sq. miles.
Garu ..	22	10	32	3·6	17	11	28	
Lat ..	..	..	..	..	6	2	8	
Latehar ..	..	..	..	..	2	3	5	
					Plus	2 cubs.		
Chhipadohar	..	..	..	..	2	2	4	
Total for Palamau	22	10	32	3·6	27	18	45	5·28
					Plus	2 cubs.		
Kodarma ..	..	..	..	..	2	3	5	9·00

1938 FIGURES.

	Male.	Female.	Total.	Average beat, sq. miles.
Garu ..	12	6	18	..
Lat ..	3	2	5	..
Latehar ..	1	1	2	..
Chhipadohar ..	3	1	4	..
Total Palamau ..	19	10	29	8·55
,, Kodarma ..	6	4	10	4·5

According to records, the following is a list of tigers shot between censuses:

Name of Range.	Between 1st May 1934 and 30th April 1936. Male.	Female.	Total.	Between 1st May 1936 and 30th April 1938. Male.	Female.	Total.	Remarks
Garu ..	3	2	5	3	1	4	
	Includes one in P. F. Mundu Block.						
Lat ..	..		1	..	2	2	
Latehar ..	2	..	2	1	..	1	
Chhipadohar ..	1	..	1	1	3	4	
			9			11	
Kodarma ..	?	?	1	?	1	2	

There is a sanctuary in Baresand block, where no shooting is allowed. In 1936 out of 28 tigers counted in Baresand block (Garu Range) 16 (10 males and six females) were found inside the sanctuary. In 1938 the number found inside the sanctuary was only eight (five males and three females). There was a fire in the sanctuary which was put out only on the 25th April 1938 and that may account for the lesser number of tigers inside the sanctuary in 1938. The maps show a greater number of tigers all round the sanctuary

in 1938 than in 1936. The fire may also account for the lower total number in 1938 compared to 1936, the animals having moved out to zamindari jungles. For instance, it was known that there was a tigress with two cubs inside the sanctuary but she was not located in the census. The concentration of tigers inside the sanctuary may be due to presence of water, more game and also absence of molestation.

A surprising feature is the low proportion of females to males and the absence of cubs. This was noticed by Mr. Nicholson in 1934 and as an explanation he suggested that certain of the recorded males were actually females. It will be noticed there has been a gradual fall in the total number of tigers in Baresand block. Assuming breeding is normal (as there is nothing to indicate this is not so) it would indicate an abnormal migration from Baresand block to outside areas. This may be due to the block being thrown open for working and tigers moving to adjoining zamindari areas.

The absence of cubs may be due to small cubs being left at home and the bigger ones being counted as grown ups. Even nearly full grown cubs are seen to follow the mother at the time of coming to kills to feed and the result of the census would indicate that at other times the cubs are more independent and move about on their own.

As regards sexes, in 1934 there were 22 males and 10 females and allowing for three males and two females killed, the number should have been 19 and eight. Actually, however, 17 males and 11 females were counted and it would seem there is a tendency to equalise the number of the sexes. Between 1936 and 1938, three males including two big cubs and one female were shot; thus we should have expected to find 14 males and 10 females against the actuals of 12 males and six females. Is the greater shortage in the number of females due to their needing greater protection and moving away from the fire? May is not the rutting season for tigers and the sexes are not expected to be together but still the disparity is remarkable. In the case of other animals, it is usual to have a preponderance of females over males: it is, perhaps, nature's provision to reproduce the loss caused by enemies of the species. In case of tiger, which has no natural enemies, no such provision would appear to be necessary: on the contrary, man, who is practically the only enemy of tiger would shoot males by preference.

It will be interesting to have similar data from other divisions in Bihar and if possible from other parts of India. From a general observation I would say there used to be more tigresses than tigers in Sambalpur.

TIMBER PRICE LIST, AUGUST-SEPTEMBER 1938
(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Assam ..	Logs ..	Rs. 30-0-0 per ton in Calcutta.
Benteak ..	*Lagerstrœmia lanceolata*	Bombay ..	Squares ..	Rs. 36-0-0 to 80-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-4-0 per c.ft.
Bijasal ..	*Pterocarpus marsupium*	Bombay ..	Logs ..	Rs. 42-0-0 to 84-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-11-4 to 1-3-1 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-4-0 per c. ft.
Blue pine ..	*Pinus excelsa* ..	N. W. F. P.	$12' \times 10'' \times 5''$ ..	Rs. 4-3-0 per piece.
,, ..	,, ..	Punjab ..	$12' \times 10'' \times 5''$ ..	Rs. 4-13-0 per piece.
Chir ..	*Pinus longifolia* ..	N. W. F. P.	$9' \times 10'' \times 5''$ ..	Rs. 1-11-0 per piece.
,, ..	,, ..	Punjab ..	$9' \times 10'' \times 5''$ ..	
,, ..	,, ..	U. P. ..	$9' \times 10'' \times 5''$ ..	Rs. 3-4-0 per sleeper.
Civit ..	*Swintonia floribunda* ..	Bengal ..	Logs ..	
Deodar ..	*Cedrus deodara* ..	Jhelum ..	Logs ..	
,, ..	,, ..	Punjab ..	$9' \times 10'' \times 5''$ ..	Rs. 3-14-0 per piece.
Dhupa ..	*Vateria indica* ..	Madras ..	Logs ..	
Fir ..	*Abies & Picea* spp. ..	Punjab ..	$9' \times 10'' \times 5''$ ..	
Gamari ..	*Gmelina arborea* ..	Orissa ..	Logs ..	Rs. 0-10-0 to 1-4-0 per c.ft.
Gurjan ..	*Dipterocarpus* spp. ..	Andamans ..	Squares ..	
,, ..	,, ..	Assam ..	Squares ..	Rs. 50-0-0 per ton.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 30-0-0 to 35-0-0 per ton.
Haldu ..	*Adina cordifolia* ..	Assam ..	Squares ..	Rs. 1-4-0 per c.ft.
,, ..	,, ..	Bombay ..	Squares ..	Rs. 24-0-0 to 68-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-13-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-3-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-9-0 per c.ft.
Hopea ..	*Hopea parviflora* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Indian rosewood ..	*Dalbergia latifolia* ..	Bombay ..	Logs ..	Rs. 52-0-0 to 100-0-0 per ton.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-12-0 to 1-4-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 2-2-5 to 3-12-0 per c.ft.
Irul ..	*Xylia xylocarpa* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Kindal ..	*Terminalia paniculata* ..	Madras ..	Logs ..	Rs. 1-4-0 to 1-5-6 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 36-0-0 to 72-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-12-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-12-1 to 0-14-2 per c.ft.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	Rs. 1-2-9 to 3-14-0 per piece.
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 25-0-0 to 75-0-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 to 5-4-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-0-0 to 2-4-0 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 20-0-0 to 75-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Rs.0-8-0 to 1-3-0 per c.ft.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 to 5-0-0 per sleeper.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 1-10-0 per sleeper.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-0-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-0-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-14-3 to 5-4-0 per sleeper.
Sandalwood ..	*Santalum album* ..	Madras ..	Billets ..	Rs. 331-0-0 to 633-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Rs. 1-8-0 to 1-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-0-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 31-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	Rs. 1-0-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Rs. 0-12-1 to 1-1-10 per piece.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 0-14-0 to 1-6-6 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class	
,, ..	,, ..	,, ..	Logs 2nd class	
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-9-9 per c.ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 2-3-3 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-6-0 to 2-12-4 per c.ft.
,, ..	,, ..	Bombay ..	Logs ..	Rs. 68-0-0 to 140-0-0 per ton.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 3-14-0 each.
White dhup ..	*Canarium euphyllum* ..	Andamans ..	Logs ..	

REVIEWS

REPORT ON FOREST ADMINISTRATION IN BENGAL FOR 1936-37

One has got to comment on the extraordinary practice whereby details are given separately for the two Circles. One would imagine that a partition of the Province were imminent! The Bengal public may be impressed by a lengthy unconsolidated report: not so interested readers elsewhere.

Excluding interest charges, the surplus for the year amounted to Rs. 4,30,000 compared with Rs. 5,18,000 in the previous year. In addition, revenue forgone through free grants or concessions amounted to Rs. 39,000. The decrease in the surplus is imputed mainly to a decline in prices due to over optimism in the previous year on the part of purchasers.

The proposal to constitute a Working Plan Division was approved of by Government. In two important respects Working Plan prescriptions were not carried out. As in previous years, creeper cutting continues to be in arrears, and regeneration to fall seriously behind the programme prescribed. In the Northern and Southern Circles the area successfully regenerated amounted to only 38 and 13 per cent. respectively of the area prescribed. Costs of new plantations rose from Rs. 7 to Rs. 8 per acre in the Northern Circle, and fell from Rs. 5 to Rs. 4 in the Southern Circle.

The scale of departmental exploitation operations was curtailed. The Siliguri Saw Mill showed an actual profit of Rs. 3,417. Production costs were reduced from Rs. 1-8-4 per c.ft. in 1935-36 to Rs. 1-2-10 per c.ft. The saving was mainly due to a change in the process of sawing which resulted in wastage being reduced from an average of about 50 per cent. in previous years to 36 per cent.

The Silvicultural research programme shows increased attention to the problem of inducing natural regeneration of sal, which, in view of the impossibility of working up to the artificial regeneration programme, has now become, as in most other sal Provinces, of major importance. Successful results have been obtained with controlled burning in sal plantations of over eight years age.

The local timbers used in the new Government House, Darjeeling, have stood up to local conditions, and the experiment has proved to be an unqualified success.

The report draws attention to the acceleration of river erosion caused in recent years by disforestation of the upper watersheds of rivers in places outside British India. Bengal is not the only Province in India to suffer in this respect. Federal action is necessary.

J. W. N.

PUNJAB FOREST ADMINISTRATION REPORT, 1936-37

Working Plans.—The revision of Working Plans continued satisfactorily, and Form 11 shows that there are now sanctioned plans for all important forest areas. The method (recently introduced) of transferring balances from one Circle to another within a Working Plan Area seems to be working well and proving very useful.

Natural Regeneration.—Natural regeneration is satisfactory except in the Himalayan spruce and fir forests, where a lack of demand for these timbers is still holding up normal regeneration fellings; and in the Kangra and Rawalpindi chir forests, where young growth is constantly destroyed by fire.

Forest Protection.—Protection against unauthorised grazing and felling is getting more and more difficult in the low hill forests. This is only natural when population increases and forest growth deteriorates.

16,239 offences were reported against 14,685 last year and 13,355—the average of the past three years. It is well known that recorded offences are a very small percentage of those which actually occur. Government now says, it views this open disregard of forest rules "with grave concern" and has appointed a Commission to enquire into the circumstances which are responsible for these deplorable results. Forest Officers, of course, know only too well what these circumstances are, and it is to be hoped that they will really be listened to.

Jallo Resin Factory.—An important event of the year was the purchase by Government of Sir Daya Kishen Kaul's share in the Jallo Resin Factory. The co-partnership agreement was terminated and Government assumed full ownership of the factory. Government had to pay Rs. 3,13,731 for this share but it has now

almost a complete monopoly of resin in the Province. During the year, which was a very favourable one, nearly 40,000 maunds were collected—some 5,000 maunds more than in 1935-36, and the Jallo Concern paid 11.8 per cent. on the capital.

Erosion.—Good work continues to be done in the fight against erosion although, as the Chief Conservator points out, the problem is not strictly a forest one but one of land management to be handled by the Revenue Department with the help of Specialist Officers.

Dr. Gorrie—the Provincial Silviculturist—carried out a detailed survey of the erosion conditions in the Uhl Valley at the request of the Hydro-Electric Branch, whose engineers are worried over the shortage of winter flow for the Jogindarnagar Hydro-Electric Turbines. The Silvicultural Research Division made a study of the affected areas in the Jhelum and Kangra districts.

Two I. F. S. Officers were detailed to work and report on certain areas in the Jhelum, Gujrat, Ambala and Gurgaon districts. Their reports showed that a great deal of soil conservation and flood control can be effected by means of—

(*a*) rotational closures of common grazing land;
(*b*) replacement of grazing by grass cutting on common and private lands;
(*c*) improvement of contour ridging to conserve rainfall on fields; and
(*d*) simple engineering projects which can be undertaken by organised village labour at a very small expense to make new fields by catching of flood water and silt behind bunds.

Mr. Hamilon, M.C., I.F.S., has now been working in the Hoshiar pur Chos for three years and all the Punjab Forest Officers must have been glad to see, in the last Birthday Honours, that his success had been appreciated by Government and that he had been honoured with the O. B. E.

Finance.—The financial position of the Province is as difficult to assess as ever. The Chief Conservator shows a loss of Rs. 3.30 lakhs on the year's working, but the Secretary to Government thought the form of accounting "not quite satisfactory" and calculated a profit of Rs. 25.58 lakhs. When two such eminent authorities get such a different answer to the problem, what can a poor reviewer say?

G. D. K.

ANNUAL REPORT ON GAME PRESERVATION IN BURMA, 1936-37

(Superintendent, Government Printing and Stationery, Burma, Price eight annas.)

The report reveals that a great deal of progress has been made, and that the question of game preservation is being tackled with enthusiasm and official support. Well protected Sanctuaries totalling over 600 square miles, and a New Wild Life Protection Act should bring reassurance to the many people who once feared that the large and varied fauna of Burma was doomed.

The same difficulties experienced elsewhere in connection with game preservation are being felt in Burma, and the chief of these is the system of issuing licences and ammunition for crop and life protection purposes. The Burma figures are interesting. There are no less than 35,499 licensed firearms in the country, but only 15,282 are licensed for sport, the remainder are either for protection purposes or for those entitled to exemption. Useful experiments are being carried out with regard to grazing, but once again that bugbear, Erosion, is raising its ugly head in areas which are burnt to provide fresh grass for herds of bison and *saing*. Elephant control is well in hand now and the sanctuaries are free from the infectious diseases usually spread by domesticated cattle. This ever present danger forms a very important consideration in the future welfare of wild animals in the sanctuaries. The opening up of Pidaung Sanctuary somewhat in the manner of the Kruger National Park will be much appreciated by the large majority of people who would like to see the many fine animals in their wild state.

The financial results show a net profit of some Rs. 14,000, but this is of purely academic interest as the intention is, probably, not to use the Wild Life Protection Act as a source of revenue. It would appear that many items of expenditure have been debited to the Forest Department Budget, which is very closely connected with the objects of the new Act.

The Game Warden has written a short but very interesting report, giving sufficient details to enable one to see what has been achieved and what further improvements are required. It is to be

hoped that other Provinces in India will follow the lead given by the African Provinces, Burma, and the Punjab, and take steps to ensure that their birds and animals shall be given ample protection to save them from extermination. In this respect India is easily a very bad last.

There is a slight error on page 5, paragraph 17; a female sambhur is a "hind" and not a "doe."

A. M. D.

TIMBER DRYING AND THE BEHAVIOUR OF SEASONED TIMBER IN USE

BY R. G. BATESON, B.A. (Oxon). (London: Crosby Lockwoods, 1938.)

This excellent manual on timber seasoning, which is copiously illustrated in half tone and line drawings, and which gives a readable account of the principles of timber drying and also of the methods of air and kiln drying of wood, is written by Mr. R. G. Bateson, who is in charge of the timber seasoning research at the Forest Products Research Laboratory, Princes Risborough, England. Within a compass of 138 pages, Mr. Bateson has explained in very clear and simple language, understandable even by a non-technical reader, the fundamentals of wood seasoning, and described the methods of stacking wood for air seasoning, the way to construct and operate a timber seasoning kiln, and the behaviour of seasoned wood in use. The last subject is of interest to many more besides those engaged in the timber trade, as a knowledge of the changes in moisture content of wood with variations in atmospheric humidity is of use to architects and others engaged in building construction, and helps them in preventing losses due to shrinkage and swelling of wood in use. The book is essentially meant for English readers, as it deals with climatic conditions prevailing in Great Britain and refers to woods available in the English market, but nevertheless it will appeal to readers abroad for a general discussion of the subject in simple language.

On page 61, kiln drying schedules for two Indian woods are mentioned, namely for gurjun and teak, which in my opinion do not represent a reasonable treatment for average wood of these

species. Our experience with these woods has been different, and I feel I should express it here. Gurjun when dried at a relatively high humidity is apt to warp and shrink more than when dried under low humidity conditions, and Schedule F would be more appropriate than Schedule E. For teak Schedule F is a bit too drastic, particularly when the initial moisture content of wood is high, and I would prefer Schedule "C" for this wood. The Schedule recommended by Knight for one inch teak flooring (*vide* Forest Products Research Records No. 23) is even milder than Schedule C.

Under air seasoning no mention is made of vertical stacking of sawn material, which method is very useful for the preliminary seasoning of woods liable to stain and decay. On page 19 it is stated that "Moulds which grow readily on moist timber do not penetrate the surface." This statement is not quite correct. On page 79 (fourth line from top), in place of "ammonium chloride gas," it would be better to say " fumes or vapour of ammonium chloride." Again, on page 90, when speaking of "piling sticks," I presume that by "1 inch in section" is meant "1 inch square in section." These few errors, however, do not detract from the value of the book, which is well worth a perusal by those engaged in timber-drying practice.

S. N. K.

ABSTRACTS OF INDIAN FOREST LITERATURE ISSUED DURING THE QUARTER ENDING 30TH JUNE 1938, TOGETHER WITH ABSTRACTS OF ARTICLES PUBLISHED IN THE "INDIAN FORESTER"

CHOPRA, R. S. *Phulahi* (*Acacia modesta*, Wall). *Pj. For. Notes* (*S*). *No.* 3: 1—11. 1937.—Describes the occurrence, habitat and silvicultural requirements of *Acacia modesta* together with results of germination tests and methods of artificial regeneration. Direct sowings are considered the best way of raising plantations. The plant is very resistant to drought.—*M. V. Laurie.*

CHOPRA, R. S. *Harar Cultivation in the Punjab. Pj. For. Notes* (*S*). No. 4: 1—4. 1937.—Describes the occurrence, habitat and silvicultural characteristics of *Terminalia chebula* together with methods of cultivation. Transplanting nursery seedlings is preferred to direct sowing. For tanning purposes the best fruits are collected before they are quite ripe.—*M. V. Laurie.*

GORRIE, R. M. *The Conservation of Punjab Water Supplies. Paper No.* 216 (S). 197—208.—Discusses erosion and run-off in the Punjab with special reference to the grazing lands of the Pabbi Range. Figures are given for the quantity of soil lost per acre in Rhodesia and different parts of America and concludes with recommendations for the prevention of erosion in the Punjab.—*M. V. Laurie.*

KAPUR, C. L. *Protection of Prosopis juliflora Pods. Ind. For. LXIV* (4): 239. 1938.—Pods of *Prosopis juliflora* that are infected with the early invisible stages of the weevil *Caryoborus gonagra* are destroyed even if stored in dry sand in airtight tins. Preliminary fumigation is advised to kill the weevils.—*M. V. Laurie.*

PURKAYASTHA, C. S. *Four new species from Assam. Ind. For. LXIV* (5): 4 pls. 276—281.—The author describes *Quercus milroyii* (Fagaceae) from N.E. Frontier Tract, *Salacia khasiana* (Celastraceae) and *Ilex khasiana* (Ilicineae) from Khasi Hills and establishes a new genus *Purkayasthaea* (Lauraceae) containing a single species *P. pseudomicropora* from Lakhimpur District.—*M. B. Raizada.*

(To be continued.)

EXTRACTS

EPHEDRA

Although the drug Ephedra has been known to the Chinese for thousands of years, its introduction into Western medicine for the treatment of asthma and hay fever is quite a recent step. The drug consists of the dried stems of certain species of *Ephedra,* small shrubby plants, the shoots of which somewhat resemble in appearance the common "horse tail," although quite distinct botanically. The value of these stems depends on their content of the alkaloid ephedrine and its isomeric form pseudoephedrine; other alkaloids are often present as well, but these apparently have no medicinal value.

Plants of the genus *Ephedra* occur in many of the warm dry regions of the world, but the species containing sufficient quantities of ephedrine or pseudoephedrine to be of commercial importance are few and somewhat restricted in their geographical distribution. Although plants from Europe and Northern India have been used, by far the greatest part of the world's supply of the drug comes from China. Five species are stated to occur in India, chiefly at high

altitudes in the mountains of Baluchistan and the Himalayas, while two of them have been recorded also from Western China. In investigations of Indian Ephedras which have been carried out by Krishna and Ghose (Indian Forest Records, 1930, Vol. 16, II) very promising results were obtained from analyses of two closely allied species, *E. nebrodensis* Tineo and *E. gerardiana* Wall. These proved in some cases to contain a higher proportion of ephedrine than *E. sinica* from China; indeed, one sample of *E. nebrodensis* from Lahoul yielded 1.93 per cent. of ephedrine, which far surpasses the content of the average Chinese material. It must be noted, however, that plants of the same species from different localities were found to vary considerably in alkaloid content.

Outside China and India various species grow in Persia, Arabia, Somaliland, Europe and the Mediterranean region. So far as can be traced from the literature available at the Imperial Institute, only three of these, namely *E. vulgaris* var. *helvetica, E. distachya* and *E. alata,* have been found to contain any useful alkaloid. The first is said to form the source of the European material. Little information is available about *E. distachya* outside China, but *E. alata* is of particular interest as a possible new source of the drug, for a sample from Morocco was found to contain as much as 1 per cent. of pseudo-ephedrine. The plant is known to occur also in Arabia, but there appear to be no published analyses of material from that country.

Of the New World species, those growing in the United States contain no useful alkaloids, and little is known of the South American representatives.

The distribution of Ephedra is strictly limited to arid regions, and it may be generalised that the useful species require also a relatively high altitude (the Indian species occur up to 16,000 ft.) and correspondingly cool climatic conditions. Whereas the alkaloid content of the Chinese species is said to be greatly affected by altitude, Krishna and Ghose (*loc. cit.*) found that the influence of rainfall plays a much more important part in the case of the Indian Ephedras, a high content of ephedrine being associated with a low rainfall, while even a single heavy rain-shower will bring about a temporary reduction in alkaloids. Thus rainfall may have a modifying effect on the general seasonal trend of the alkaloid content, which is said normally to show a steady increase through the summer months,

reaching a maximum in the autumn. In spite of the effect of local climate, however, it is still generally true that the ephedrine content is highest in the autumn, and it is customary for the Chinese to harvest the stems at this season.

It has already been mentioned that practically the whole of the world's supply of Ephedra comes from China. This source has been largely cut off as a result of the war, and it is doubtful to what extent the 1937 crop has been gathered. The same is true also of Spain, which formerly produced small quantities of the drug. Towards the end of 1937 the market situation was becoming serious as the existing stocks were extremely low, and there was no immediate prospect of further shipments. The price of ephedrine hydrochloride in bulk quantities, which at the end of July had been about 5*s*. per oz. had reached over 20*s*. per oz. by November 1937. The beginning of 1938 saw a slight falling off in price to 15*s*. per oz. for the hydrochloride and 20*s*. for the pure alkaloid, whilst by May the price had fallen still further to 8*s*.—9*s*. per oz., c.i.f., for June shipment. The improvement in the position is said to be mainly due to the introduction on the market of synthetic ephedrine hydrochloride, which it is claimed complies with the British Pharmacopœia Specification. It is understood, however, that the cost of production of the synthetic drug is much more than the normal market value of the natural product, and that its position on the market is therefore not likely to be maintained. The normal demand for the drug has increased very considerably in recent years, and further increases are likely as its use in medicine becomes more general.

Attention has naturally been drawn to the possibility of producing the drug in Empire countries, either by exploiting any naturally occurring species or by introducing the Chinese material into cultivation.

Various species of Ephedra do grow wild in such countries as Cyprus, Palestine and British Somaliland, but their value remains as yet unexplored. In view of the work of Krishna and Ghose referred to above, India appears promising as a possible source of the drug, and it is urged that efforts should be made to develop trade in the Indian Ephedras. So far there is not a great deal of information available regarding the quantities in which material of high ephedrine content could be supplied from India. It is worth noting

however, that, as long ago as 1928, 34 tons of the drug were shipped to the United States, whilst it is recorded that during March, 1938, two consignments, aggregating nearly 80 tons, reached that country from India.

Among the Empire countries where the Chinese species of Ephedra might be introduced, Kenya has been suggested as a possibility, and it is understood that trials have just been started there with material supplied from Kew. It will be interesting to see whether the plants will thrive and give a good yield of alkaloid under the conditions obtaining in that Colony.

Details of the plant's cultural requirements and adaptability to new soil and climatic conditions are very little known. Various species have been cultivated in England, both at Kew and elsewhere, but in all cases growth was extremely slow and the alkaloid content far too low to be of any value. Trials carried out in the United States by Christensen and Hiner, in South Dakota, proved more successful; these are fully described in the *Journal of the American Pharmaceutical Association*, Vol. 25, 1936, pp. 969--73. Seed of *E. sinica*, obtained from Peking Union Medical College, was planted in 1929 and showed excellent germination within a fortnight. Plants from the first lot of seed were reared in a greenhouse, but it was later found that the plants were hardy and would reproduce readily from seed in the open. The young plants were cultivated in nursery beds for at least two years before planting out in the field. Propagation from suckers also presented no difficulty, and it is stated that the new plants transplant well by severing them from the old root and allowing them to remain undisturbed for about three weeks before moving to their new location.

The best time for harvesting was found to be late autumn before the first frost. The crop was simply mown in the ordinary way and allowed to cure in the field, like hay; this gave better results than oven-curing. Although the plants were large enough to cut after two years, it was found better not to harvest too soon as the alkaloid content of the young shoots is very low. Even in older plants which have been cut the previous year the new stems of one year's growth contained little ephedrine. The stems proved winter-hardy under South Dakota conditions, although blackening somewhat, and those of two years' growth yielded up to 0.36 per cent. of ephedrine.

The climate in South Dakota where the plants were grown is rather dry and sunny, with very cold winters. The average summer

temperature is given at about 70°F., while the winter average is below −30°F., and sometimes for more than 60 days in the year the temperature does not rise above freezing all day. The summer growing period, free from severe frosts, is from early May to late September, on an average about 130 days. There were two regions where the Ephedra was growing—one between 2,000 and 4,000 ft. altitude with an annual rainfall of less than 15 in., the other below 2,000 ft. having a rainfall of about 25 in. In both cases the rain comes almost entirely in the summer.—*Bulletin of the Imperial Institute, Vol. XXXVI No. 2 (April-June 1938), pages 205—209.*

COMMERCIAL ASPECTS OF THE SUNDARBANS DIVISION*

By Mr. S. Chaudhuri, B.A. (Oxon.),

Deputy Conservator of Forests.

The Sundarbans.—The tract of land known as the Sundarbans is the southern part of the Gangetic delta. It traversed a short time back the portion of South Bengal bordering the sea from the Hoogly to the Megna. With the increase of population and the extension of cultivation, the Sundarbans are confined now to the forest tract—about 4,000 square miles—from the Channel Creek in the west to the Madhumati or Baleswar in the east within the civil districts of 24-Parganas and Khulna.

The history of the Sundarbans is an account of river action in Bengal; it shows how Bengal was created by rivers, how the land was fertilised by rivers, how Bengal thrives with a fine river system —how the forests protect the rivers and the land—how a badly looked after river system has been the cause of the present position of the province.

Flora.—The Sundarbans consists of a number of low lying swampy islands, most of which are under water twice a day during spring tides. The vegetation is largely of mangrove type accompanied by semi-tidal species like *sundri* (*Heritiera minor*) and *gengwa* (*Excœcaria agallocha*). Amongst the Sundarbans species the most important tree is the *sundri*—a circumstance to which the region owed its name. Associated with the *sundri* are the several characteristic trees such as *gengwa* (*Excœcaria agallocha*), *amur* (*Amoora cucullata*), *passur* (*Carapa moluccensis*), *baen* (*Avicennia officinalis*), *dhundal* (*Carapa obovata*), *golpatta* (*Nipa fruticans*), *keorea* (*Sonneratia apetala*) and *kankra* (*Bruguiera gymnorhiza*). As one approaches the sea to the south or to the west where fresh water is no longer coming down, the water becomes extremely brackish, and

*Appendices have not been reproduced.

sundri gives place to *goran*. These forests are remarkably free from any undergrowth. The difficulty of extraction from the stump to the rivers is due to the spreading aerial roots of the mangroves and the thick and pointed breathing roots (the pneumatophors) of the *sundri* and other species.

Fauna.—The wild animals of the Sundarbans include tigers, wild pig, wild cats, deer, porcupines, otters and monkeys. Wild buffalo and rhinoceros, which were common once upon a time, are now extinct.

King-fishers of various kinds, vultures, kites, owls, moinas, doves, storks and paddy birds are common.

Game birds include wild geese, wild duck, jungle fowl, cranes, snipe and partridges.

The rivers and estuaries of the Sundarbans are infested with crocodiles and sharks. Fish abound in nearly all the rivers and estuaries. The most valuable fish caught are the well known *Betki* (*Latis Calcarifer*), the delicious *Topshi* (*Polynemus Paradiscus*) and the *Hilsha* (*Clupea Ilisha*) and *Chingri* and *Crabs* (*Crustacea*).

The presence or absence of fresh water appears to have played a very important part in the stocking of fish and animals. If some of the rivers like the Ichamati or the Matla could be reconnected with the main flow of the Ganges, the whole picture of Central Bengal with its flora and fauna will change very considerably.

Natural calamities which effect the management.—FLOOD.—The northern part of this tract is liable to occasional flood, but the severity of such inundations is far less than it used to be about a century ago when a large portion of the volume of the Ganges water poured down to the sea through this area.

CYCLONES.—These districts are exposed to cyclones which sweep up from the Bay of Bengal often accompanied by destructive storm waves.

FAMINE.—Famines are the worst calamities which these districts are subject to.

At the outset I should like to sound an emphatic note of warning against the growing popular misconception of the true object of management of the Sundarbans. These forests were reserved as much for the purpose of protection against natural calamities as for the satisfaction of the demands of the neighbouring population for

forest produce. The primary consideration should be that of keeping the area under perpetual tree cover. Commercial aspects should only be subservient to the above.

Products of commercial interest.—The products of commercial interest according to existing markets are: —

(1) *Sundri* timber and firewood.
(2) *Passur* timber.
(3) *Gengwa* timber and firewood.
(4) *Baen* timber and firewood.
(5) *Goran* poles and firewood.
(6) *Keora* timber.
(7) *Amur* poles
(8) *Dhundal* timber.
(9) *Golpatta.*
(10) *Kankra, Singra, Khalshi, Garjan* and other miscellaneous species.
(11) Honey and wax.
(12) Shells.
(13) Fish.
(14) Skins.
(15) Salt.

A short note on each of the above is given below: —

(1) *Sundri.*—A gregarious tree with dark red heartwood; good for boat building and very durable under water; also a good firewood.

(2) *Passur.*—Good for posts and planks; a good furniture timber.

(3) *Gengwa.*—The most widely distributed tree of the Sundarbans. Once considered a pest on account of the corrosive milky juice in its bark, which led to serious attempts in the past to wipe it out of the forest. A white, light timber good for packing; bigger sizes suitable for match boxes. The fuel, although of small caloric value, is extensively used by the poor for its cheapness.

(4) *Baen.*—The biggest tree of the Sundarbans and the most popular timber species giving fairly wide planks; the hollow trunks are used as sluice pipes; yields good firewood for the potters.

(5) *Goran.*—More a shrub than a tree. Used for house posts by the poor; a very good firewood; the bark is used for tanning.

(6) *Keora.*—*Keora* is the most striking tree in the Sundarbans. The first tree species to cover new land formations. The wood is light but has a pretty, light brownish colour; used for ceiling and interior works.

(7) *Amur.*—A small tree. Good for *hookah* stems and oar blades.

(8) *Dhundal.*—A small tree. In very great demand for making pencils and pen-holders.

(9) *Golpatta*.—The leaves of this palm are responsible for an annual revenue of a lakh of rupees; extensively used for thatching.

(10) *Kankra, Singra, Khalshi, Garjan* and other miscellaneous species do not occur in sufficient quantities to deserve special consideration. They are used only locally in small quantities.

(11) *Honey and wax*.—These form the basic materials for a lot of articles of trade. but the extent of adulteration to which they are subjected after they leave the forest and before they reach the Calcutta market is truly deplorable.

(12) *Shells*.—Used locally for burning into lime.

(13) *Fish*.—Fishing in Khulna is of considerable importance affording a large number of persons their only means of livelihood, even though this industry has not been properly developed yet.

(14) *Skins*.—Lizard skins were in great demand until very recently, but fashions have changed, and crocodile skins have replaced the former.

(15) *Salt*.—Even in the early days of the British administration one of the principal industries of these districts was the manufacture of salt which was of sufficient importance "to necessitate the employment of a considerable staff with headquarters at Khulna and of a small military force." The industry was practically dead but during the last year or so two salt factories have sprung up.

The keynote of success of any business is harmony of demand and supply. So far as commercial activities in any forest product are concerned the geographical position plays a very important part—it determines to a very large extent not only the kind and amount of timber, etc., that can be produced but also the degree to which products can be utilised. On the ultimate possibility of disposal depends the intensity with which forestry can be practised.

So far as means of transport are concerned the Sundarbans are very favourably situated, connected as they are by waterways with Calcutta, 24-Parganas, Jessore, Khulna, Barisal, Faridpur and Dacca.

Standing forests, from a commercial view-point, have value only when, through trade and industries, they can be converted into wealth. It is false economy to attempt to develop an industry the basic materials for which are not available in sufficient quantities to ensure successful continuance of operation. Re-stocking of exploited areas is essential. In this matter the Sundarbans forests are

very fortunate in that natural regeneration of the principal species is plentiful.

From the statements given in Appendix it will be seen that there has been gross overfelling of species like *gengwa, golpatta, baen* and *dhundal,* and insufficient exploitation of other species like *sundri, passur* and *keora* before the introduction of systematic management under Mr. Curtis's Working Plan.

Sundri.—Regarding *sundri,* the future policy should be to push the sale of firewood as much as possible. It will be inadvisable to compete with sal in the timber market, especially as the output of sal is bound to increase due to new reservations and plantations. *Sundri* lasts very well under water, but the drawback is that there is no chance of recovering a *sundri* boat once it capsizes. In recent years we have advocated the construction of boats with an admixture of other species with *sundri* to increase the buoyancy.

Even at the beginning of this century there were excellent pasture lands and scattered jungles on the banks of rivers and inside the villages. They afforded good opportunities for rearing cattle and were sources of supply of fuel for household consumption. With the increase of population and the decline of local trade and industries, agriculture has become the only means of livelihood for 90 per cent. of the population, every available bit of waste land has been brought under the plough—firewood has become scarce—and the people have taken to the burning of cow-dung and coal. The result has been the deprivation of the fields of necessary manure and the wasting of a valuable mineral like coal, the stock of which is by no means inexhaustible. The consumption of coal could with advantage be restricted to locomotives and industrial purposes for which India is at present an importer.

During recent years it has been possible to increase the sale of *sundri* firewood from 8 lakhs of cubic feet in 1912-13 and 6½ lakhs cubic feet in 1930-31 to nearly 20 lakhs cubic feet in 1936-37 (*cf.* Appendix) by reopening *sundri* for local use and pushing its sale in East Bengal. There is ample scope for further extension in this direction.

Passur.—*Passur* is imported from Burma by one or two Calcutta firms for the manufacture of furniture. Specimens have been sent

to a firm to try this out but the results are not available. The timber has all the qualities of a first class furniture wood.

Smaller sizes of this species have been reported on well for pencil wood as a substitute for *dhundal*, for which purpose it may be used. The supply is still in excess of local demand.

Gengwa.—The demand for *gengwa* is of two distinct types, one for a fairly big size (12″ diameter and over) for match factories, and the other for box planking for inferior packing; for the latter sizes even as small as 6″ diameter are used although trees 8″ to 10″ diameter are generally preferred. There are very few *gengwa* trees of 12″ diameter and above in the Sundarbans at present; and trees of such sizes can be grown only in areas where fresh water is available. The major part of the division can produce *gengwa* of smaller sizes only.

The world's demand for softwoods is increasing day by day, and of the Sundarbans species *gengwa* has, in my opinion, the surest market; but nothing special has been done so far to improve the situation. I would suggest—

(*i*) favouring this species in thinning against the hardier *sundri*;

(*ii*) the disposal of *sundri* as firewood even at cheaper rates from the so-called moderately salt water areas where *sundri* is at present unsaleable.

(*iii*) thinning of *gengwa* for dunnage in its younger stage.

Negotiations for the sale of *sundri* on a large scale from these areas have so far proved unsuccessful but there is just a chance of a contract of 6 lakhs maunds per annum, and I am sure if we continue to study the market conditions of Calcutta, which is the commercial centre for the whole of Bengal, some further solution of this problem may be obtained.

Baen.—*baen* has been so much over-exploited in the past (*cf.* Appendix) that it has latterly become impossible to meet local demands. *Keora* is being substituted for this species. *Baen* has a very coarse but ornamental grain and has possibilities for cabinet work; but considering the limited stock at our disposal and the time it will take to divert the local taste to other timbers it is not advisable to try to encourage the sale of this species beyond the local market.

Goran.—The sale of *goran* as timber is really up to the maximum permissible. But there is further room for increase of sale as firewood.

Keora.—With the fall in the supply of *baen* the demand for *keora* has gone up. Extraction and transport in big sizes to distant places is an impracticable proposition. The only possibility is to export it in roughly fashioned standard sizes. Owing to its gregarious occurrence in newly formed *chars* along river banks and its imposing appearance, it is bound to give an exaggerated view of its abundance. But the actual working of the last 5 years' coupes has shown that there is really not much more than can be absorbed by the growing local market.

Amur.—Although *amur* is at present mainly in demand for the the manufacture of *hookah* stems and oar blades, it has recently been reported favourably for pencils and pen-holders by a Calcutta firm; and will, together with *passur,* be able to make up for the diminishing supply of *dhundal.*

Dhundal.—There is possibility of selling *dhundal* even up to 3 or 4 lakhs cubic feet per annum. Hardly 50,000 cubic feet per annum were available in the coupes for the last 6 years. As observed above *passur* and *amur* are being tried as substitutes.

Dhundal is a very slow growing species. It is one of the few valuable species that thrive in extremely saline conditions. It grows only along the river banks. Steps should be taken to regenerate this species artificially.

Golpatta.—*Golpatta* has been very much over-cut in the past and proper protection has been afforded only recently by the introduction of the coupe system as suggested in the Working Plan. The supply is hardly sufficient to meet the present demand.

The habits of this palm, as ascertained by experiments carried out during the last three to four years, have proved beyond doubt the possibility of regenerating it artificially. Extension of *golpatta* by artificial means is advocated.

Garjan.—The bark of *garjan* has been well reported on for its tanning content, but the stock is too small to admit of expansion on any commercial scale.

Honey and wax.—The reservation of certain blocks each year as bee sancturies has so far given very good results, but the seasonal

output of honey and wax varies with the early or late advent of the rains. It is necessary by legislation or otherwise to put a stop to the appalling extent of adulteration that goes on in the hands of middlemen.

Shells.—Collection of shells is a very tedious and slow process, and the conditions in which the permit holders work are very difficult owing to the obnoxious smell emitted by the decomposing animal organisms. Capital invested in this business takes a long time to obtain returns and this accounts for the lack of any appreciable expansion of this trade although there is a lot of material available.

Fish.—Although next to rice, fish is the staple food of Bengalis, it is deplorable that fisheries in Bengal have been sadly neglected. This natural food resource is continually being reduced by insufficient and wasteful means of catching and marketing and the sacrifice of fishing grounds for the benefit of agriculture. No attempt has yet been made to exploit marine fisheries. But the Sundarbans surely offer ample scope for the development of this trade.

Skin.—The main onslaught for ornamental leather is directed against crocodiles at present. The collection of skins should be so controlled as not to interfere with the balance of nature. Too easy terms for permit holders might result in the total extermination of this reptile.

Salt.—The decline of the salt industry in India has resulted in the import of lakhs of maunds of this commodity into the country. Some industries have just opened and it will, in my opinion, be in the interest of the department and the country to extend a helping hand to the endeavours of these infant industries.

Financial aspect.—The area of the Sundarbans Forest Division is 3,946 square miles. The total outturn of timber and firewood in 1936-37, which is only an average year, was 1,00,74,864 cubic feet. The gross revenue from this forest estate for the year under review was Rs. 5,19,843, the cost of management being Rs. 2,89,285, which gives a surplus of Rs. 2,30,558. This works to an average yield of 2,553 cubic feet of timber and fuel per square mile and gross and net income of Rs. 132 and Rs. 58 per square mile respectively.

The above figures show that the value of produce dealt with is very insignificant per cubic foot, but it is owing to the vastness of the

area and the comparatively low expenditure on management, *viz.*, Rs. 74 per square mile, that such a big income is possible.

The past Government have handed down to the province a property which, leaving aside the protection it affords the people of the 24-Parganas and Khulna against the ravages of cyclones and storm waves, is providing the Government with a surplus of over 2 lakhs of rupees per annum which from now onwards, with closer utilisation and wise management, should continue to increase. This will only be possible if the present popular Government continues to listen to the voice of their experts and is not led away by the popular clamour for cutting down forests.

The problem of future control and development of the Sundarbans is not any more the allotment of areas to rival claims of tillage and forest but one of saving the dying and moribund river system of Central Bengal.—(*Extract from the Proceedings of the Indian Forest Service Officers' Conference held at Darjeeling from 27th September to 2nd October 1937.*)

SOME COMMON FALLACIES ABOUT WOOD

Forest Products Laboratory, Madison, Wisconsin.

In the course of its work the Forest Products Laboratory continues to encounter various false ideas about wood, many of which lead to unnecessary trouble, expense, or dissatisfaction in the use of wood. Some common misconceptions of this kind are the following:

Fallacy 1.—That wood used in construction is under all conditions more dangerous than steel in case of fire.

It is true that wood soon becomes charcoal when heated to about 572°F., and that steel is little affected at such temperatures. But wood has one tremendous advantage in that it is a poor conductor of heat, so that the outside of large beams or thick planks may burn or char while the inside retains its strength. Steel in the same fire and carrying the same load is very rapidly heated through, and not infrequently loses its strength and drops its load sooner than wood.

In the case of a burning barn, with the hay on fire, where it is a question of minutes or seconds whether you can save the livestock, the extra support given to the structure by heavy timber framing as compared to light steel members might make all the difference.

Fallacy 2.—That all wood in the course of time "naturally" decays as a result of age.

This fatalistic concept ignores the true cause of decay and may lead the user to neglect proper precautions against it. Time or age in itself has nothing to do with the decay of wood. The White House, when remodelled in 1928, was found to contain sound roof timbers that had been in place since 1816. The Fairbanks house, a wood structure in Dedham, Mass., is standing structurally intact after three centuries. Timbers several hundred years old have been recovered from the ruins of Indian pueblos in Arizona and New Mexico. A part of a Roman emperor's houseboat that sank long ago in Lake Nemi was sound enough nearly 2,000 years later to be identified by the Forest Products Laboratory as spruce. A log 7 feet in diameter was found not long ago in a tunnel being dug 150 feet below the bed of the Yakima River in Washington. A piece of it was sent to the Forest Products Laboratory and the wood was identified *as an extinct species of Sequoia, of an age estimated by geologists at 12 million years.*

These examples prove that wood does not *necessarily* decay with age at all. *Decay* is the result of one thing only, and that is the attack of wood-destroying fungus. In the cases mentioned the wood had been kept free of fungus attack in one of two ways:—It had been kept *dry*, as in weatherproof structures or in a dry climate, or it had been kept thoroughly and permanently saturated. A fungus is a plant. If the wood is too *dry* for it to grow and spread, decay does not occur. If the wood is thoroughly saturated, the fungus is "drowned out." The range of activity of fungus lies between 20 per cent. moisture content of the wood and a nearly "soaking wet" condition.

Fallacy 3.—That some wood *never* decay, regardless of exposure and service conditions.

Both this fallacy and the second one are answered by the fact that *no* woods decay when fully protected from fungi, and that *any* wood will decay when exposed to fungus attack that is severe enough and long enough continued.

The conditions that bring about decay of wood are, briefly, dampness and mild to warm weather. If you have a house, porch, or shed built over damp, poorly drained ground, with the foundations

bricked or boarded in, look out for decay. Sills of untreated wood resting directly on damp ground are sure to rot. Likewise untreated posts and poles set in the ground are exposed to ideal conditions for fungus attack and their service will usually be terminated by the decay near the ground line, no matter what wood is used.

The sapwood of all species is easily and quickly destroyed by decay. (Sapwood is the outer, light-coloured part of the tree trunk.) But it is a fact that the *heartwood* of some species resists decay longer than the heartwood of others. This is the advantage of using for fence posts, and so on, such durable species as cedar, catalpa, chestnut, southern cypress, juniper, black locust, osage-orange or bois d'arc, and redwood. They may last for years. Do not imagine, however, that the underground parts of the post will remain just as you put them in; in a comparatively short time decay will eat away the sapwood, and the business of holding up the fence will be left to a core of the more resistant heartwood. Of course, by treating the wood with a good preservative you change the picture materially. The preservative goes mostly into the sapwood and protects the part that is most vulnerable to decay.

But to suppose that the use of cypress, cedar, or any other special wood will excuse you from all precautions against decay is a bad mistake. Don't expect *too* much of Nature. In the first place, remember that only the heartwood is the durable part, and then take care of the service conditions as well as you can. A Laboratory man once went to inspect a floor that was falling in. It happened that the subfloor was of genuine cypress, specifically put there to ward off decay, but alas! It was laid directly over damp ground and was covered with tar paper before laying the upper boards. What the owner had was a high-powered *fungus pit* for his cypress, and the fungus literally "went to town" at the owner's expense.

Fallacy 4.—That there is such a thing as "dry rot" of wood.

Much has been written or said about "dry rot" in buildings. Any brown, crumbly rot is so called, but the term is a misnomer. No fungus can grow without water. Wood is the food for the wood-destroying fungi, but they cannot use that unless it contains at least 20 per cent. of water (based on the weight of the oven-dry wood). However, the fungi which are responsible for a large amount of decay in buildings are capable of rotting wood that is apparently much

drier for they produce *water-conducting strands which carry water from some source, usually in the ground, up into buildings where the wood normally would be dry.* Moreover, some wood-destroying fungi can remain dormant in dry wood for months or even years and then revive and continue their destructive work as soon as moisture becomes available.

Call it "dry rot" if you wish, the kind of fungus that comes sneaking into a house carrying its water supply with it; it is a bad one, and should have been kept out by proper precautions when the house was built. Its Latin name is *Poria incrassata.* It is at home in the South, on the Pacific Coast, and at least as far north as Pensylvania and Nebraska.

Here is an illustration: A house was completely wrecked by this destroyer in less than 10 years. Investigation showed that some floor joists were allowed to rest on an *old stump* that happened to be in just the right place—or the wrong place. Don't give this wrecker a chance to get into your home by leaving planks or timbers connecting the structure with the ground. After *Poria incrassata* gets started it can set up its own connections with the damp ground, an ugly, snakelike growth sometimes as big as your finger and thumb.

A good, dry, well-built frame house is in practically no danger from decay if just a few normal precautions are taken: (1) Build on a well-drained site; (2) secure well-seasoned lumber from a yard where rot in foundations and lumber piles is not tolerated, rejecting any material that is suspected to contain incipient decay; (3) do not allow the selected material to lie on the ground after it has been delivered on the job; (4) untreated lumber should not be allowed to come in contact with the soil or with foundations or walls which are liable to be damp, and should not be embedded in concrete or masonry without leaving ventilation around the ends of the timbers; (5) wood flooring, unless it has been chemically preserved, should never be laid directly on the soil or on concrete that is in contact with the soil; and (6) ample ventilation should be provided so that free circulation of air around the wood will keep the wood dry.—*(United States Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, Wisconsin, in co-operation with the University of Wisconsin, May* 1938.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for July 1938:

IMPORTS

ARTICLES	MONTH OF JULY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
Siam ..	110	1	209	15,692	130	23,169
Burma ..	..	12,334	14,957	..	15,16,709	18,42,693
French Indo-China	57	..	1,673	7,232	..	2,04,286
Java .	..	600	43	..	80,164	6,220
Other countries ..	..	105	..	..	11,076	..
Total ..	167	13,040	16,882	22,924	16,08,079	20,76,368
Other than Teak—						
Softwoods ..	1,051	2,125	1,286	59,595	1,73,446	94,317
Matchwoods ..	656	1,072	624	35,468	57,316	44,509
Unspecified (value)	..	..	..	20,018	1,80,412	3,36,146
Firewood ..	14	41	69	210	615	1,039
Sandalwood ..	10	30	20	5,265	11,449	9,577
Total value ..	..	..	..	1,20,556	4,23,238	4,85,588
Total value of Wood and Timber ..	..	..	..	1,43,489	20,31,317	25,61,956
Manufactures of Wood and Timber—						
Furniture and cabinetware ..	No data			No data		
Sleepers of wood ..	..	14	4	..	1,622	800
Plywood ..	279	552	337	63,485	1,01,911	81,258
Other manufactures of wood (value) ..	..	..	..	1,47,647	1,61,135	1,54,791
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	2,11,132	2,64,668	2,36,849
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	9,632	33,509	33,015	70,741	2,76,466	2,97,654

EXPORTS

ARTICLES	MONTH OF JULY					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	2,332	40	..	4,93,664	6,156	..
„ Germany ..	327	..	..	76,967	..	..
„ Iraq ..	76	14	50	18,548	3,145	15,514
„ Ceylon ..	28	..	..	3,807	..	..
„ Union of South Africa ..	222	..	..	40,507	..	..
„ Portuguese East Africa ..	112	..	..	20,084	..	..
„ United States of America ..	52	..	..	15,641	..	..
„ Other countries	401	67	187	73,316	18,947	63,767
Total ..	3,550	121	237	7,42,534	28,248	79,326
Teak keys (tons) ..	129	..	..	17,700	..	..
Hardwoods other than teak ..	144	..	..	14,440	..	72
Unspecified (value)	..	..	..	43,490	76,389	31,703
Firewood ..	..	..	..	..	..	..
Total value ..	..	..	..	75,630	76,389	31,775
Sandalwood—						
To United Kingdom	..	..	10	..	..	12,000
„ Japan ..	5	5	..	5,500	6,000	..
„ United States of America ..	..	..	..	..	..	..
„ Other countries	20	47	8	24,975	45,437	7,905
Total ..	25	52	18	30,475	5,1437	19,905
Total value of Wood and Timber ..	..	..	..	8,48,639	1,56,074	1,31,006
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	13,825	26,112	45,675
Other Products of Wood and Timber		No data			No data	

INDIAN FORESTER

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A ROUGH GUIDE TO THINNING DEODAR BASED ON AVERAGE SPACING FOR A GIVEN GIRTH

BY R. S. CHOPRA, P.F.S.

In view of Mr. Laurie's article in the *Indian Forester* for July 1938, on a rough guide to teak thinnings, the following note on the practice of thinning deodar in the Punjab may be of interest. In this Province the young saplings are first cleaned to approximately 6 x 6 feet when about 6 feet high. Early thinnings cease when the sapling crops attain a D.B.H. of 6—8 inches at which stage the espacement is about 6 feet to 8 feet. Thereafter regular thinnings begin and are carried out on a graded 10—15-year cycle till the crops reach a D.B.H. of 18—20 inches and fall due for preparatory fellings. In qualities I and II deodar the intensity of thinnings at each decade is regulated by four times the girth thumb rule; *i.e.*, the average espacement after each thinning approximates to four times the mean crop girth at breast height. The rule owes its inception to Mr. H. M. Glover, Conservator of Forests, Eastern Circle, Punjab, and under his able guidance its application in deodar crops during the last 20 years has produced excellent results. The majority of deodar forests worked under the Punjab Shelterwood System fall under the yield tables quality class I/II. The following table, therefore, compares the spacing obtained under this rule with that of Champion and Mahendru's Multiple Yield Tables for deodar quality class I/II:

Thinning grade.	Age.	D.B.H.: inches.	Corresponding girth: inches.	No. of stems per acre.	Corresponding spacing: feet.	Spacing by 4×G thumb rule: feet.
C	30	5·3	16·7	985	6·6	5·6
	40	7·6	23·9	591	8·6	8·0
	50	9·7	30·5	419	10·2	10·2
D	60	12·4	39·0	242	13·4	13·0
	70	14·2	44·6	204	14·6	14·9
	80	15·6	49·0	182	15·5	16·3
E	90	18·0	56·6	113	19·6	18·9
	100	19·3	60·6	103	20·5	20·2
	110	20·4	64·1	95	21·4	21·4

It will be observed that the $4 \times G$ thumb rule gives approximate spacing corresponding to "C" grade up to 50 years, "D" grade from 60—80 years, "D"/"E" grade at 90 years and finally that of "E" grade thinnings. It needs no argument that for deodar a heavier thinning than "C" grade is not desirable during the first half of the rotation to safeguard against the development of side branches which deteriorate the quality of timber. But once the lower branches are shed and the boles are cleaned a heavier thinning is undoubtedly called for to accelerate the development of individual trees and finally towards maturity its intensity may further be increased with advantage as an initial stage to preparatory fellings. Thus it is abundantly clear that $4 \times G$ rule furnishes a sound silvicultural basis for deodar thinnings and is sufficiently correct for practical use. It not only serves as a useful guide to subordinates as to the intensity of thinnings required but is also of great help to the skilled forester for marking divisional thinnings as it obviates the necessity for lengthy and complicated calculations with the help of yield tables to arrive at number of stems to be left per acre to carry out a particular grade of thinnings. Such simple rules devised for the major Indian species will go a long way to make silviculture easy for the practical forester.

ROOT COMPETITION AND AVAILABLE NITROGEN IN THE SOIL

By M. V. Laurie, Central Silviculturist.

Abstract.—The vegetative response to removal of root competition in trenched plots was formerly explained as being chiefly due to increased available moisture in the soil. Recent work in Sweden in spruce forests suggests that increase in available nitrogen may be the chief factor, this being correlated with the killing of mycorrhizal fungi.

The classical experiments of Fabricius (2) in Germany and Toumey (7) in America on the effects of removal of root competition in trenched plots under forest canopy are well known to most forest officers. Small plots varying in size from one to ten or more square yards in extent were surrounded by a trench dug to a depth of two to three feet so that all roots down to that depth entering the plot were cut. The trenches were then filled in again. The results were in most cases remarkable and striking. Greatly increased

vegetation, improved regeneration and in general healthier greener plants with more rapid growth occurred within the plots than in the control areas outside.

The general explanation put forward at the time was that the removal of root competition caused improved moisture conditions within the plots. Competition for other food materials was, it is true, mentioned, but available moisture was considered to be by far the most important factor.

Romell (5) in Sweden, in the course of his investigations into the role of microbiological activity in mor formation and mor activation did some similar trenching experiments in spruce forests, the results of which lend support to a microbiological explanation of the result as affecting increase in available nitrogen. His explanation is that the fungi of the soil are of two main categories, namely, those that decompose litter and break down organic residues rendering the nitrogen in them available for plant growth, and those that form a mycorrhizal association with the living tree roots and which, in general, are incapable of breaking down organic residues, and are dependent upon the living root for most of their organic food materials and are only capable of absorbing from the soil mineral nutrients and nitrogen in the forms in which it is usually available to plants (3), (4). On removing root competition by trenching, these mycorrhizas on the cut roots die with them and a considerable drain on the available nitrogen reserves in the ground is thereby removed. The dead roots with their dead mycorrhizas also add to the nitrogen on being decomposed by the ordinary wood-rotting fungi in the soil.

Romell showed that the resulting growth was similar to that obtained by adding nitrogenous fertilisers to the ground. The leaves of the plants are a darker shade of green, there is a lag in the autumnal colour change and a striking increase in the amount of grass in the plots. The same striking colour changes are to be seen in the coloured illustrations accompanying the published results of Fabricius' (2) experiments. Romell, however, does not appear to have made any soil analyses to substantiate his theory that the results are chiefly due to increased available nitrogen though the appearances strongly suggest this.

Romell (5) puts forward a similar explanation for the response of trees to thinnings. The former idea that the resulting stimulus to growth after thinning was due to improved light conditions for the crowns has been widened in recent years to include the effects of reduced root competition for water chiefly, and also for nutrients, and Romell's work indicates that increase in available nitrogen may be an important factor especially in the conditions under which he did his experiments. These were in spruce forest on a naturally moist soil where competition for water could not be an appreciable controlling factor.

It appears, therefore, that in forests where competition for soil moisture is not appreciable and especially where active mycorrhizas exist in association with the trees, the removal of root competition by trenching, thinning or other means may result in an immediate increase in available nitrogen in the soil which may, in some cases, be an important factor stimulating growth.

Root competition experiments in India have, so far, given varying results. The nearest approach to the European and American trenching experiments are those made in deodar forests in the Punjab in 1932, but which do not appear to have resulted in a notable increase in vegetative activity in the trenched plots as compared with the controls. Another experiment in Madras attempted to assist the establishment of regeneration of *Hopea parviflora* in tropical evergreen forest by trenching to remove root competition. The results were negative, and this was put down to the moist type of forest. It would be interesting to know whether, in addition, mycorrhizal activity is low in these forests and whether, as would appear probable, there is little active competition for nitrogenous food materials in the soil.

Trenching experiments have been done along the edges of older forest crops adjoining young regeneration to determine the effect of root competition on the latter. Very definite results were obtained in the case of teak in Madras (*c.f.* also the work in Java), and an appreciable difference was found in sal at Dehra Dun. Removal of competition underground from weeds in a teak plantation experiment in Madras by continuous clean weeding throughout the first year produced nearly three times the growth of

the control plants raised with ordinary divisional weeding practice. This was in a moist climate and the differences were apparent before the end of the monsoon (though much of the extra growth took place later by an extension of the growing season after the normally treated teak had stopped). A portion, therefore, of this extra growth cannot be attributed to water shortage and must have been due to competition for soil nutrients. Removal of the coppice regrowth of stumps after thinning young sal had a very definite beneficial effect on the growth of the remaining trees, but it is not known whether this is primarily due to elimination of competition for water or nitrogen or other nutrients or a combination of all three. Romell's work in Sweden mentioned above brings a new aspect of this perennially interesting and important problem into view, an aspect about which we are at present almost entirely ignorant in this country.

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THE INFLUENCE OF HOST PLANTS ON SANDAL AND ON SPIKE DISEASE

BY M. G. VENKATA RAO, B.A., DISTRICT FOREST OFFICER,

BHADRAVATI DIVISION (MYSORE STATE).

Summary.—(1) Good and bad hosts of sandal can only be differentiated when grown individually with sandal. It cannot be based on the selective tendency of haustorium, as good and bad hosts are often equally well attacked. The deleterious effects of bad hosts are not discernible when sandal is also feeding on good hosts.

(2) Details are given of cases of (a) hosts which are easily killed by sandal, (b) toxic hosts which kill sandal, (c) hosts which cause discoloration in leaves of sandal and (d) hosts which alter the habit of sandal.

(3) The sandal haustoria not only absorb the crude sap from host plants but often take up other ingredients found in the roots of host plants, such as alkaloids in *Strychnos nux-vomica*, and the composition of the sap is thus altered. To ascertain if any sandal-host combination is immune to spike disease, 108 different host plants which included a large number of Indian medicinal plants were grown with sandal in pot-cultures and tested with artificial inoculation. None of the combinations tried could resist the disease.

(4) Attempts at classifying these combinations as "more susceptible" and "less susceptible" to the disease are considered futile and misleading, as the differences as regards resistance, if any, are generally slight and often not beyond experimental errors. In addition, even if sandal in any combination survive a few years more than others when exposed to natural infection it is not of any practical value in the case of young sandal which develop scented wood only after they are 15 to 20 years old, as in spiked areas they are killed by the disease soon after they overtop the bushes in which they are growing.

INTRODUCTION

It is well known that sandal is a root parasite from its infancy. The parasitic nature of the plant was first discovered in 1871 by Mr. John Scott, Curator of the Royal Botanic Gardens, Calcutta, but little notice of the same was taken for the next 30 years.

The investigation of the spike disease in sandal led to the study of root parasitism of the plant by Barber (1) who has described the sandal haustorium in great detail. Sandal seedlings survive only about a year if grown pure without any hosts. The seedlings grow normally for two to three months on the food material stored in the hypocotyl and then the growth ceases if the parasite does not form root connections with host plants. It is not definitely known if the well grown sandal trees are also obligatory parasites. The writer has experimented with well grown potted sandal plants three to four

years old and deprived them of their hosts. The plants have always succumbed in two to three years. To get this result it is necessary to carefully exclude the growth of grasses and small annuals. The growth of sandal is profoundly influenced by the host or hosts it feeds upon and there are both good and bad hosts of sandal.

If any antidote to spike disease could be found in the roots of medicinal plants, it could be easily administered to sandal by growing such plants as hosts. This formed a most important line of study in the investigation of the disease and the results obtained are discussed in this paper.

The function of sandal haustorium.—The roots of sandal scarcely develop any root-hairs to suck water from the soil, and instead haustoria are developed to get the supply from host plants. During the act of penetration by sandal haustorium Barber showed that a ferment was active in dissolving the cell-walls, but it was not known if the products of this solvent action were absorbed by sandal. Haustoria sometimes penetrate only the bark of the host root, and it was not known if in such cases they absorb the elaborated sap of host plants. In 1920 the writer found (4) all parts of sandal growing with *Strychnos nux vomica* intensely bitter. Samples of leaves, bark and wood of such sandal were examined by Mr. Shankar Rao Badami, Senior Assistant Chemist in the office of the Director of Agriculture in Mysore, and strychnine was found in the leaves, bark and sapwood. This clearly proves that the haustorium, in addition to taking its supply of water from the host plants, may also absorb other materials from the hosts. The writer subsequently found that leaves and bark of sandal feeding on *Alangium lamarckii* are very bitter, just like those of the latter, the root-bark of which is used in skin diseases and poisonous bites. Similarly, the leaves of sandal grown with *Azadirachta indica,* the margosa tree, show the distinct flavour of the host to the taste, though the peculiar smell of margosa is absent.

The ingredients of the roots of host plants are, however, not always found in the sap of sandal feeding on them. While the alkaloids found in the hosts noted above appear to be absorbed by the sandal haustoria, ingredients such as scented essential oils, resins, etc., found in the root-bark of such hosts as *Bursera* species, camphor

and lavender plants are not discernible in sandal feeding on them and it is possible that these products are decomposed or altered during penetration and absorption by the haustoria.

It can thus be seen that some hosts conspicuously affect the composition of the sap of sandal.

Good and bad hosts.—It is impossible to differentiate between good and bad hosts by field observations, as in nature, sandal will always be feeding on more than one host. In some cases, sandal may be found in company with a single host, or no apparent host may be discernible. In such cases, the presence of grass and small annuals has been overlooked, sandal feeding on them, as well as on other larger hosts. In addition, sandal roots spread out to considerable distances. In one case, the writer found that the roots of a sandal tree had travelled a length of nearly 115 feet and attacked the roots of a large *Pterocarpus marsupium* tree, which had also spread to a distance of nearly 90 feet. Thus the sandal was feeding on a host over 200 feet away from it. Barber (2) and Rama Rao (3) state that sandal haustoria have a selective power and attack good hosts extensively and bad hosts very sparingly. On this basis, Rama Rao (3) has attempted a classification of good, moderately good and bad hosts. It is quite true that the intensity of sandal haustorial attack varies with different host plants. But it does not always follow that all hosts whose roots are extensively attacked are good hosts of sandal. In some cases, both good and bad hosts are attacked equally well. In the compound of the office of the Director of Agriculture, the writer found that castor plants which are toxic to sandal had been extensively attacked by sandal haustoria and even the size of the haustoria was nearly as large as those on *Cassia siamea*, a very good host on which the sandal was also feeding. Hence it is very misleading to judge the suitability of a host on the extent of the haustorial attack. Haustorial connections may be influenced by contact stimulus which may vary with different objects or roots of host plants with which the haustorium may come into contact. Two large sandal saplings grown in a wooden tub had over 225 haustoria firmly attached to the sides of the tub, a portion of which is shown in plate 53, whereas the good host provided for them, namely *Prosopis juliflora*, had scarcely half this number of haustoria on its roots.

Sandal haustoria on the planks of a tub in which sandal was grown. The numerous roundish dots seen are all sandal haustoria developed on the planks.

Good hosts.—The only way to ascertain the suitability of any species as a host of sandal is to grow both in pot-cultures so as to exclude all other vegetation including grasses and herbs. Good hosts are those plants on which exclusively sandal can thrive and grow vigorously. From pot-culture experiments, the writer has ascertained that among the natural orders Leguminoseæ contains some of the best hosts of sandal, such as *Cassia siamea, Pongamia glabra, Dalbergia sissoo, Prosopis juliflora, Acacia farnesiana, Pterocarpus marsupium,* etc. It is sometimes thought that all legumes are good hosts of sandal which is not the case, as some really bad hosts are also found in this order. Among other natural orders, some of the good hosts found are *Thespesia populnea, Tecoma stans, Bambusa arundinacea, Dendrocalamus strictus, Adhatoda vasica, Datura stramonium, Casuarina equisetifolia, Lantana camara,* etc.

Hosts which are easily killed by sandal.—The capacity of different host plants to withstand the parasitism of sandal show considerable variations. This can only be clearly seen in pot-culture experiments, as in nature the sandal will be feeding on several plants at the same time and, in addition, the deep-rooted species may escape the bulk of the haustorial attacks, as sandal has a very superficial root-system. In pot-culture experiments, any host can be killed by sandal if several sandal plants are made to feed on a single host. But when each sandal is provided in pot-cultures with a single host of approximately the same age as the sandal, differences in withstanding the parasitism of sandal haustòria, among hosts of different species are clearly discernible. Such hosts like *Cassia siamea, Dalbergia sissoo, Pongamia glabra, Prosopis juliflora, Tecoma stans* and *Casuarina equisetifolia* can support the sandal plants feeding on them without themselves collapsing. In all cases the normal rate of growth of the host is lowered by the parasite. But there are other host plants such as *Acacia farnesiana, Acacia suma, Datura stramonium, Tabernæmontana coronaria, Cassia auriculata,* and *Tephrosia candida* which are unable to withstand the drain of sap taken up by sandal and are killed in one to two years. Among the various hosts experimented with the writer found that sandal kills off *Tephrosia candida* more quickly than any other species tried. In several pot-cultures each sandal was provided with three to four hosts of *Tephrosia* but they were all killed off within a year. Of

course these are only good hosts that are killed by sandal as, in the case of bad hosts, the sandal itself cannot grow well and hence the host is not seriously affected.

Bad hosts.—Among the species which are commonly found associated with sandal in nature, there are often a larger number of bad hosts than good ones. But under field conditions, as already stated, it is impossible to differentiate between good and bad hosts, as sandal will be feeding on several plants. In pot-culture experiments, where single hosts are provided, it was found that sandal would not thrive on several species of hosts. The sandal was killed off in some cases, while in others it scarcely showed any appreciable growth. In such cases it is of greatest importance to carefully exclude any grass or weeds from ever growing in the pots, as many of them are moderately good hosts of sandal and hence vitiate the results.

But in all these cases, whenever a good host was given, in addition, the sandal plants started growing normally. Hence, whenever sandal is feeding on both good and bad hosts, as in nature, the deleterious effect of the latter is not discernible.

Hosts which kill sandal.—There are considerable differences in the deleterious effects produced in sandal by the different bad hosts, when they are grown individually with sandal. They vary from stunting the growth of sandal to actually killing it. The following are some of the toxic hosts which kill sandal in one to two years: castor plant, *Carica papaya, Phyllanthus emblica, Anacardium occidentale, Erythrina indica, Spondias mangifera* and *Sapindus trifoliatus*. Most of the species in the order of *Anacardiaceae* are more or less toxic to sandal. In all the above cases whenever a good host is also given, in addition, the sandal plants do not die but start growing normally, though they may be feeding on the toxic hosts, and hence under field conditions some of these toxic plants appear as though they are really very good hosts. For example, in the office of the Director of Agriculture, in Bangalore, the mycologist had raised several sandal with *Erythrina* on a small plot of land and the sandal feeding also on other local vegetation have grown remarkably well. But when sandal was given only this host it was killed within two years (Plate 54). The experiment was repeated several times

"H" is the host Erythrina indica which has in one year and three months, nearly killed the sandal plant marked "S" in the picture. The sandal died three months after the photo was taken.

and in all the 18 pot-cultures tried with this host, the same results were obtained. The sandal repeatedly shed its leaves, twigs started drying, and ultimately became nearly leafless before collapsing.

Hosts which cause discoloration of leaves in sandal.—A few hosts have been found to produce discoloration in the leaves of the sandal feeding upon them. In castor and sandal combination the leaves on twigs of the latter are considerably reduced in size and get crinkled. A reddish discoloration starts at the tips of the leaves and extends along the margin of the blade. In the discoloured portion the cells are dead and withered. These leaves quickly drop off and the sandal is deprived of most of the leaves so that just before the plant dies the leaf-bearing twigs will scarcely have more than two pairs of leaves.

In the case of sandal grown with *Azadirachta indica, Clausena willdenovii,* and *Sesbania grandiflora,* the leaves develop dark red to reddish streaks, which impart a kind of mosaic appearance. This discoloration is generally not found in young leaves but confined to fully grown ones. The first two species are moderately good hosts while the third is a bad host.

In sandal and *Vitex trifolia* combination, the leaves of sandal as they mature develop a dark brown or blackish coloration all over the leaves. This is so conspicuous that the writer, when he first observed it, suspected it to be some disease. *Vitex trifolia* in other respects is a fairly good host, as sandal thrives fairly well on it.

The discoloration in the above cases is not generally seen when sandal is also feeding on good hosts of other species.

Host which alters the habit of sandal.—A host which produces a most extraordinary effect on sandal is *Crotalaria anergioides,* a large perennial shrub. This is an exotic introduced into Mysore as a valuable manurial plant. When sandal feeds on this host the leaves and the shape of the crown of sandal undergo remarkable transformation. The sandal leaves get altered into an oval or oblong shape, the tips of the leaves are conspicuously rounded and the internodes shortened. The apical growth of shoots is stunted and ceases prematurely, and dormant buds below the shoots start growing repeatedly. This results in excessive, short and crowded branching,

giving the sandal an extraordinary appearance of a low depressed habit with a rounded crown and bushy appearance as shown in Plate 55.

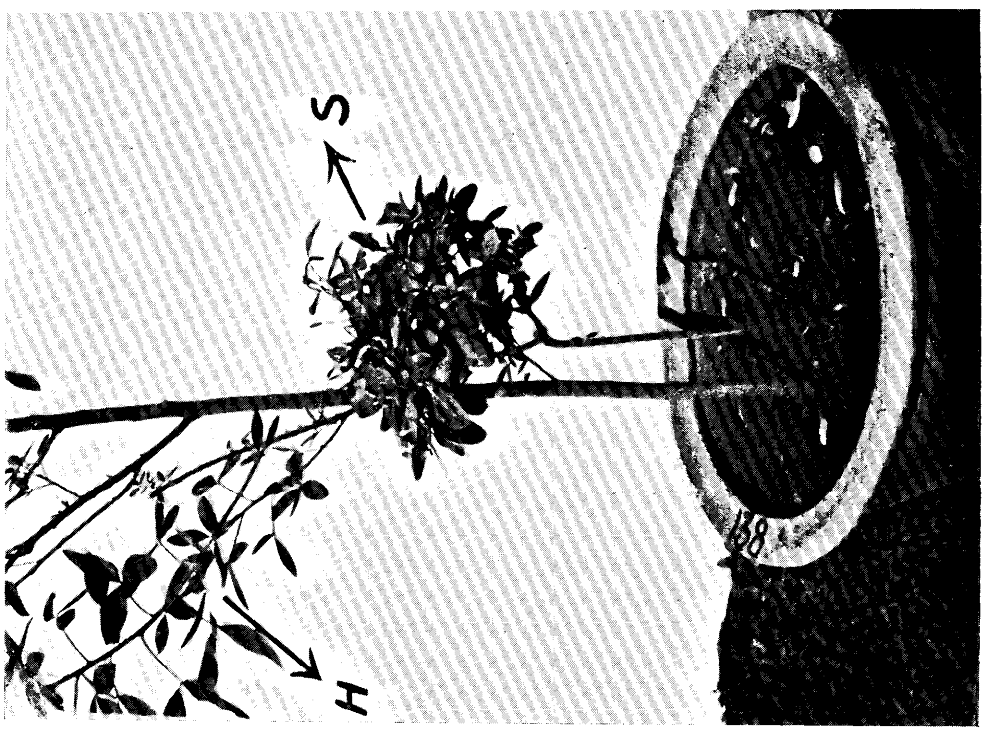
This host was also tried for *Santalum yasi,* the sandal of Fiji Islands, on which it produced the same results. As already stated the peculiar effects produced on sandal by certain hosts are not seen when sandal is also feeding on other hosts. But in the case of this *Crotalaria,* it was found that though sandal was allowed to feed upon several other hosts both in pot-cultures and in field conditions, the modifications of the leaves and crown of sandal as noted above were always conspicuous. When sandal is grown with rain-tree, the leaves of sandal are abnormally elongated and their width diminished. But this effect is not seen when hosts other than rain-tree are also present.

The influence of host plants on spike disease of sandal.—The possible ways in which host plants may affect the incidence of spike disease of sandal are:

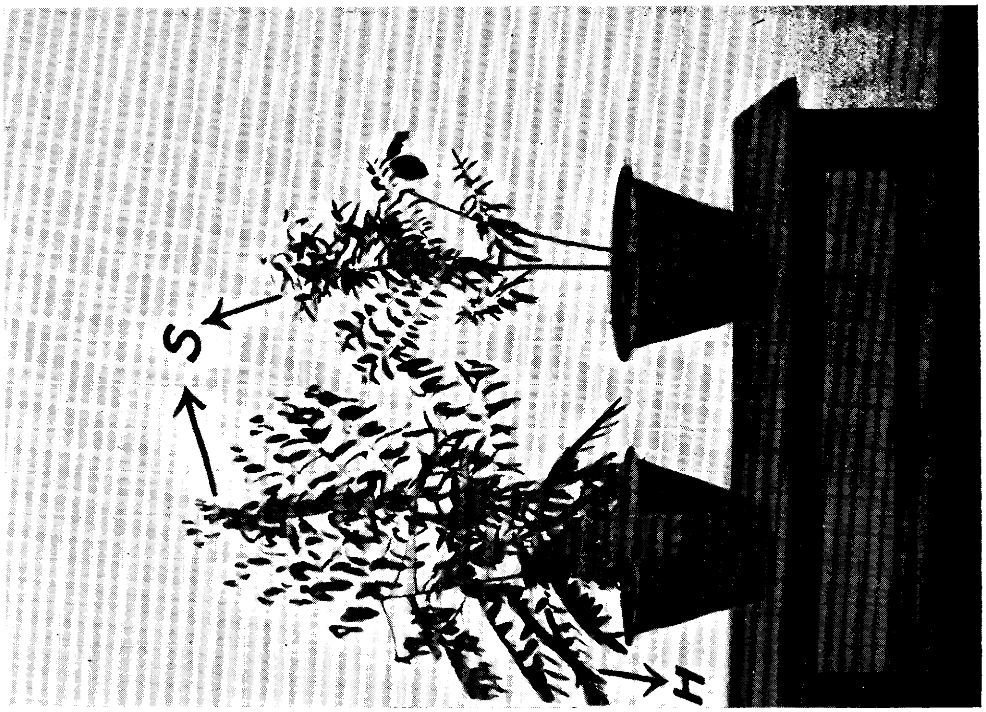
(1) by affecting the vitality and vigour of growth of sandal,

(2) by altering the composition of the sap of sandal by the addition of ingredients absorbed from the host by sandal haustoria.

(1) *Vigour of growth.*—As already explained, the vigour of growth of sandal is profoundly affected by the hosts on which the sandal feeds. In pot-culture experiments it has been found that there is no correlation between the vigour of growth of sandal and its susceptibility to spike disease. Well grown and vigorous plants are as susceptible to the disease by artificial inoculations as those which are stunted. In nature also it is seen that in any area where the disease appears, vigorous large trees are as quickly attacked as those which are ill developed or in poor condition. It is therefore probable that good host plants, in so far as they contribute to vigour of growth of sandal, have no appreciable effect on the incidence of the disease. But the period of survival after the appearance of the disease is generally governed by the vitality of the sandal plants and sturdy well grown plants may survive two to two-and-a-half years while others in a poor condition may succumb in a few months.



"H" is the host Crotalaria anergioides.
"S" is sandal, whose shape is strikingly altered by the host.
The crown is flattened and presents a bushy appearance,



This picture shows for comparison the normal shape of sandal.
"S" is sandal.
"H" is the host Cassia siamea,

(2) *Hosts which may alter the composition of the sandal sap.*— It has been proved by the writer (4) that in some cases the active principle or ingredients found in the roots of some host plants such as *Strychnos nux-vomica* may pass into the sandal sap through the haustorium. It is, therefore, possible that there may be hosts containing an antidote to the spike virus, and the antidote may be passed on to sandal feeding on such hosts, and make it immune to the disease. To ascertain this possibility, over one hundred different species of hosts were grown in pots with sandal and tested with artificial inoculations. The hosts selected included some very important Indian medicinal plants and a few exotics. In the case of bad hosts on which sandal does not thrive, additional good hosts were provided. To get comparable results, this additional host given was the same in all cases, being *Acacia farnesiana*. The sandal grown with different hosts were inoculated with buds or bark grafts and it was found that no sandal-host combination raised was immune to the disease. In some cases a second inoculation was necessary to produce the disease, but rarely a third. It is very misleading to consider the combinations which took a second inoculation as more resistant than others as it may be due to the resistance of the individual sandal experimented upon, rather than to the host combination or to the low concentration of the virus in the bud or bark graft used in the first inoculation. This was further verified by repeating the experiments where a particular sandal-host combination took more than one inoculation. For example, while in one pot a sandal grown with *Dalbergia sissoo* took three inoculations to develop the disease, in another pot, a sandal grown with the same host got the disease after a single inoculation. A peculiar reaction to the inoculations was noticed in the case of sandal and *Strychnos nux-vomica* combination. The sandal lost all its leaves and died without producing any spiked leaves. The experiment was repeated among a large number of sandal saplings grown with this host in nursery beds. In the case of two large sandal saplings four to six feet high, after a few spiked leaves appeared, the plants collapsed, lost all their leaves and died. In the case of smaller saplings, they all collapsed similarly but without developing any spiked leaves.

The writer tested 108 different sandal host combinations with artificial inoculations and found none immune to the spike disease.

Of course there are several other hosts which have not been tried with sandal, but from experience gained so far, it appears that the chance of findng a host which confers immunity to sandal from the disease is very remote. A search was also conducted in several old spiked scrub jungles to find out the existence of any large sandal trees which had resisted infection in association with any particular hosts, with negative results. None of the associate species commonly found in sandal areas appear to confer any immunity to sandal. The writer, however, has not found *Strychnos nux-vomica* in spiked areas, and how this associate may react to the spread of the disease is not known. Of course this combination is not immune to artificial inoculations and hence the disease may be communicated easily to sandal feeding on this species through the haustoria but the bulk of disease transmissions in nature appear to take place above ground, possibly through insect vectors, as detailed in a previous paper (6). How far the bitter principle found in the sandal feeding on *Strychnos nux-vomica* will react on the palate of the possible insect vectors and keep them off from such sandal is not known, and it is being tested by growing this host in a heavily spiked area.

In the investigations on spike disease in sandal conducted in the Indian Institute of Science in Bangalore, attempts have been made to classify the host plants as less resistant or more resistant hosts. For example, certain hosts like *Cassia siamea, Melia indica, Dodonea viscosa, Semecarpus anacardium* are considered to make the sandal feeding on them hardy and relatively more immune to the disease. The writer is unable to subscribe to this statement as in his pot-culture experiments the disease was as easily communicated to sandal grown with these hosts as in other cases, and what is more important sandal found associated with these species is commonly found spiked in nature in infected areas. The differences, if any, in the powers of disease resistance among several sandal host combinations tested by inoculations are very slight and often not beyond experimental errors. It has been shown in a previous paper (5) that except in twig-grafts which always contain a lethal dose of virus, in inoculations by other methods such as buds, patch bark grafts, ring bark grafts, and leaf insertions, the disease develops only in certain percentage of cases varying from 17 to 63 per cent.,

depending on the kind of graft used. Hence, in these methods of inoculations a fairly large margin has to be allowed for experimental errors. It is, therefore, futile and misleading to attempt a classification of different sandal-host combinations as less susceptible and more susceptible on such slender foundation, considering that they are of no practical value in combating the disease which none of them are able to withstand.

Even assuming that, under natural conditions, certain sandal-host combinations may survive a few years longer than others in infected areas, it is of no practical value in combating the disease. In spiked areas where natural regeneration comes up profusely, it is immaterial whether the saplings are killed in three to four years after they emerge out of bushes, or survive for 10 years, as in both cases they will not have developed any heartwood. It is well known that healthy sandal do not develop any scented wood till they are 15 to 20 years old. Hence, any attempt to introduce the so-called "more resistant hosts" in spiked areas is labour and money wasted. It would be a practical proposition to grow in spiked areas any host that really makes the sandal feeding on it immune to the disease. A search for such a host, in nature as well as in pot-cultures, has so far been a total failure, and any success in this direction is extremely remote.

The following gives a list of host plants tested in pot-culture experiments by inoculation and none of which gives any immunity to sandal from the disease. The host plants have also been classified as follows regarding their suitability as hosts of sandal:

Class A.—Very good to good hosts on which sandal can thrive and grow vigorously.

Class B.—Moderately good hosts on which sandal grows with a reduced rate of growth.

Class C.—Poor, bad to toxic hosts, on which sandal can scarcely thrive or which inhibit its growth.

It is interesting to note that among the hosts tested, the percentage of plants which fall under A, B and C classes are 24, 25 and 51, respectively.

Natural order.		*Botanical name.*	*Suitability as host of sandal.*
Magnoliaceæ	...	*Michelia champaca*	C
Anonaceæ	...	*Anona squamosa*	C
Bixaceæ	...	*Taraktogenos kurzii*	C
Guttifere	...	*Ochrocarpus longifolius*	C
		Calophyllum inophyllum	C
Dipterocarpaceæ	...	*Shorea talura*	C
Malvaceæ	...	*Thespesia populnea*	A
		Eriodendron anfractuosum	C
		Bombax malabaricum	C
		Gossypium herbaceum	B
Rutaceæ	...	*Clausena willdenovii*	B
		Aegle marmelos	B
		Toddalia aculeata	B
Burseraceæ	...	*Boswellia serrata*	C
		Bursera aloxylon	C
Meliaceæ	...	*Azadirachta indica*	B
		Swietenia mahagoni	C
Celastraceæ	...	*Gymnosporia montana*	C
Sapindaceæ	...	*Dodonea viscosa*	A
		Sapindus laurifolius	C
Anacardinaceæ	...	*Spondias mangifera*	C
		Anacardium occidentale	C
		Buchanania latifolia	C
		Mangifera indica	C
		Semecarpus anacardium	C
Leguminosæ	...	*Crotalaria anergioides*	B
		Sesbania grandiflora	C
		Mundulea suberosa	A
		Tephrosia candida	A
		Ougeinia dalbergioides	A
		Erythrina indica	C
		Butea frondosa	B
		Cajanus indicus	A
		Dalbergia sissoo	A
		Pterocarpus marsupium	A
		Pongamia glabra	A
		Caesalpinia coriaria	C
		Acrocarpus fraxinifolius	C
		Tamarindus indica	C
		Cassia siamea	A
		Cassia auriculata	A

Natural order.		*Botanical name.*	*Suitability as host of sandal.*
Leguminosæ (*contd.*)			
		Prosopis juliflora	A
		Acacia farnesiana	A
		Acacia arabica	A
		Acacia leucophlœa	A
		Acacia catechu	B
		Acacia ferrunginea	B
		Acacia cæsia	C
		Acacia concinna	C
		Acacia decurrens	C
		Albizzia odoratissima	A
		Albizzia lebbek	A
		Pithecolobium saman	B
Combretaceæ	...	*Terminalia chebula*	C
		Terminalia arjuna	B
		Anogeissus latifolia	C
Myrtaceæ	...	*Eugenia jambos*	C
		Eugenia jambolana	C
		Psidium guava	C
		Eucalyptus calophylla	C
		Eucalyptus citriodora	C
		Eucalyptus cornuta	C
		Eucalyptus robusta	C
		Eucalyptus resinifera	C
		Eucalyptus rostrata	B
Lithracæ	...	*Lawsonia alba*	B
Passifloraceæ	...	*Carica papaya*	C
Cornaceæ	...	*Alangium lamarckii*	C
Rubiaceæ	...	*Hymenodictyon excelsum*	B
		Pavetta indica	B
Sapotaceæ	...	*Bassia longifolia*	C
		Bassia latifolia	C
Ebonaceæ	...	*Diospyros montana*	C
		Diospyros tupru	C
Oleaceæ	...	*Jasminum sessiliflorum*	A
Apocynaceæ	...	*Alstonia scholaris*	C
		Tabernæmontana coronaria	B
		Nerium odorum	A
		Vinca rosea	B
Asclepiadaceæ	...	*Calotropis gigantea*	B
Loganiaceæ	...	*Strychnos nux-vomica*	B
		Strychnos potatorum	C

Natural order.		*Botanical name.*	*Suitability as host of sandal.*
Convolvulaceæ	...	*Argyreia cuneata*	B
Solanaceæ	...	*Nicotiana tabacum*	B
Bignoniaceæ	...	*Tecoma stans*	A
		Stereospermum chelonoides	C
		Oroxylon indicum	B
Acanthaceæ	...	*Adhatoda vasica*	A
Verbinaceæ	...	*Lantana camara*	A
		Vitex trifolia	A
		Vitex negundo	B
		Tectona grandis	B
Aristolochiaceæ	...	*Aristolochia indica*	B
Lauraceæ	...	*Cinnamomum camphora*	B
Euphorbiaceæ	...	*Phyllanthus emblica*	C
		Jatropha curcas	B
		Ricinus communis	C
		Euphorbia tirucalli	C
Moraceæ	...	*Ficus bengalensis*	C
		Ficus mysorensis	C
		Ficus religiosa	C
		Ficus tsiela	C
		Ficus glomerata	C
		Artocarpus integrifolia	C
Casuarinaceæ	...	*Casuarina equisetifolia*	A
Amaryllideæ	...	*Agave americana*	C
Gramineæ	...	*Dendrocalamus strictus*	A
		Bambusa arundinacea	A

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Editor's Note.—The above article contains many interesting observations regarding the host relationship of sandal. A considerable amount of similar work into the suitability of different host plants, particularly with reference to their capacity for conferring resistance or enhanced susceptibility to spike disease, has been done in Madras and we understand that the methods used are those which Mr. Venkata Rao condemns as useless and also that results obtained are in some cases at variance with those expressed by the above author. It would be very interesting if the Madras workers could let us have the benefit of their experiences and express their opinions on Mr. Rao's most interesting article.

A NOTE ON LAUREL WOOD (TERMINALIA TOMENTOSA) AND ITS MARKET IN GREAT BRITAIN

BY J. N. SINHA, BIHAR FOREST SERVICE.

Abstract.—"Figured" laurel is much fancied in England. India at present supplies a quantity and the market is expanding. But "figure" partakes so much of sentiment that it is hard to define. It is harder still to tell if any given log would yield "figured" timber, and ordinary laurel wood is not cared for. In this article the opinions of certain British brokers and merchants are pooled and hints for exporters are given.

Last year when I was in England, I called at India House, London, and discussed with Sir Hugh Watson, Timber Adviser to the High Commissioner for India, the subject of marketing laurel wood in Great Britain. My object was to collect first-hand information on the following main points with special reference to Bihar laurel:

Points about Laurel

(1) The existing market and prospects of its expansion.

(2) The uses to which laurel wood is put in Britain and the form in which it is used.

(3) What is exactly understood by "figured" laurel.

(4) Size of timber preferred.

(5) Form in which the timber is best shipped.

Sources of Information

Sir Hugh Watson kindly furnished me with information in his possession and suggested that I should visit the British Industries

Fair at the White City in London that was then in session and see the laurel wood furniture exhibited there. This I did the same afternoon. He also put me in touch with one of the principal brokers (Messrs. Leary & Co.) and through them with an important hardwood merchant firm (Messrs. Fairbairns) with whom I discussed the subject at great length. I shall classify all the information that I collected under the points enumerated above:

The Market

(1) As regards the market Sir Hugh struck a pessimistic note and said that taking all things together it could be correctly stated that there was no substantial market in Britain for laurel wood. To my suggestion that laurel had very recently come into the British market and that therefore it seemed too early to arrive at such a conclusion he agreed but was not very enthusiastic. He informed me that on the average 50 tons of laurel had come annually from India during the last five years. The suppliers were mainly Bombay and Madras and secondarily Orissa and Bihar. (Bengal laurel was found to be too light coloured and therefore rejected.) Bombay, Madras and Burma had stocks far in excess of the British market's requirements, so, in Sir Hugh's opinion, it was hardly worth while for Bihar to spend much thought or labour over the subject. But as what is wanted by the market is not just laurel wood but good "figured" laurel wood, it is possible that Bihar laurel may prove itself to be the best (opinion among merchants is already favourable to Bihar laurel) and therefore most marketable despite the comparatively larger stocks of other provinces. The obvious need is to experiment and try.

In the White City I saw the stall and the representative of Messrs. John Wright and Sons (Veneers), Ltd., who are large veneer merchants. I also met at the same exhibition representatives of Messrs. Matthew Pollock, Ltd. of Beith, Ayrshire, Scotland, who are furniture manufacturers and upholsterers. Both firms thought that the prospects of the laurel wood market were quite bright, that people liked the wood and consumption was going up. Of course the market at present is limited, as it must be with any new timber.

Certain circumstances against Laurel

The limitations arise out of 4 main factors:

(*a*) Laurel wood is not yet sufficiently known in Great Britain; on the Continent not at all.

(*b*) Certain European woods, mainly walnut, resemble laurel very closely and being better known and easier to work and possibly cheaper, are naturally preferred.

(*c*) Laurel is one of the most difficult woods to work. It is so hard that the veneer knife has to be changed after a few cuts (20, if I remember aright).

(*d*) Only an odd log out of many yields really good "figure," and it is impossible to tell with certainty whether or not a given log will produce "figured" veneer.

Messrs. Matthew Pollock, Ltd., have been only using laurel for the last three years. Their experience is that the market is expanding. It may be added here that Sir Hugh Watson's figure of annual imports, namely, 50 tons, refers to the import through the High Commissioner for India alone. Sir Hugh told me that an unknown quantity of laurel wood was coming in to the brokers from private individuals in India.

(2) Uses and form in which used.

Veneers

Laurel is always used in the form of veneers. Messrs. John Wright & Sons (Veneers), Ltd. of London, are, as already said, one of the principal veneer makers. Veneers in general are made of all grades of thickness ranging between 7/8″ and 1/120″, depending upon the kind of timber dealt with, but the usual thickness of laurel wood veneer is 1/28″. At Messrs. Wrights' stall in the White City, I saw rolls of laurel veneer exhibited.

Certain uses Enumerated

At Messrs. Pollocks' stall I saw two bedroom suites panelled with laurel veneer. The suites looked very pretty. The price was £50 each. Laurel veneer was used for the front outside and side panelling only, the rest being in a different and cheaper wood.

There is a very big table in India House made of "figured" laurel.

In the office of Messrs. Wilfrid Fairbairns at 10 Cullum St., Fenchurch Street, London, I was shown toys made of laurel, but Mr. Fairbairns told me that laurel was no longer used in turnery work.

What is "figured" Laurel?

(3) What is "figured" laurel? This is a most difficult question to answer. The "figure" of laurel wood is almost as undefined as the beauty in a rose flower. Just as in the case of the flower it is possible to put the finger on certain features and describe some others that go to the making of beauty, so it is in the case of laurel wood. But the ultimate beauty of a flower is a subtle blending of the whole, an indescribable appeal to the sentiment. So is the "figure" of laurel wood.

Physical Definition

Physically speaking, "figure" is generally defined as made by wavy longitudinal bands of dark colour crossed by shiny ripples so as to produce a mottled or furrowed effect. In the first place the timber must look dark, that is, it must have plenty of well distributed dark bands. As such and without cross ripples it is not "figured," but may still be valuable. To produce "figure" the cross ripples must be prominent and ample. As regards the dark bands some prefer them straight, others wavy; also certain classes of furniture need straight bands, others would look nice with wavy bands. For instance, the bedroom suites at Messrs. Pollocks' stall looked best with straight bands. Messrs. Wrights', on the other hand, showed definite preference for wavy bands.

Opinion in grading Differs

At my request, Messrs. John Wright & Sons gave me four specimens of laurel wood veneers. I examined these and asked the representative to tell me which he considered the best "figured" and arrange the rest in order of "figure" merit. Next I took these specimens to Messrs. Pollocks' stall and requested them to tell me how they would grade these. What Messrs. Wrights had graded as the best Messrs. Pollocks graded as second best and *vice versa*. I asked Messrs. Pollocks' representative what led him to call one better than the other. He endeavoured to explain by reference to the straight flowing lines, the compact regions of black, etc., but his real answer came when with a decisive jerk he held out the specimen, looked at it awhile, and said "because it is more interesting." This one word "interesting" tells the story. It shows how much depends upon fancy.

Difficulty of Forecast.

I asked Messrs. Wrights' representative how one could tell whether or not timber in a given log would be "figured." He replied

that it was impossible to tell with certainty. I invited him to look at the question from my (*i.e.*, the supplier's) point of view; having undertaken to supply logs of "figured" laurel how could I sort out "figured" logs from those that were not "figured." What was the test? He replied that examination of pieces of wood cut out from the ends and middle of the logs would be a guide to a certain extent but that ultimately it was certain to be a gamble. One had to take chances.

The firm of Messrs. Fairbairns, introduced to me by Messrs. Leary & Co. (brokers), was the third with whom I discussed the subject. Mr. Wilfrid Fairbairns had dealt with Bihar and Orissa laurel and held a good opinion of it. He had with him and showed me a sample piece inscribed "Bihar and Orissa" which was presumably sent by our office through the Timber Adviser. That piece was considered to be an indifferent sample for two reasons:

We need to understand "Figure"

(*i*) It was not sufficiently dark, (*ii*) it had no "figure." Apparently it was sent out in the belief that it was "figured." Mr. W. Fairbairns corroborated that it was extremely difficult to tell timber in the log as regards its "figure" merit. On one occasion out of 20 logs he had found only one log "figured," but those were just random logs and not sent in for "figure." To add to the uncertainty one part of the log may be "figured" and the rest not "figured."

Size and Prices

(4) As regards the size of timber, the thicker the log the better timber it yields. Mr. Fairbairns prefers rough squared logs of 84″ in girth, measured at midpoint, but has sold even 54″ size. He informed me that about 60″ girth would sell for 3 shillings 3 pence per cubic foot, 72″ for a slightly higher price and 84″ might fetch 10 shillings. There was very small demand for smaller timber, that is, timber smaller than 72″ girth.

Laurel is hardy Timber

(5) Form in which the timber is best shipped. Rough squared is the standard form, bark and sapwood both removed. I asked Mr. Fairbairns if the ends should be coated. He did not see any use but humorously remarked that Burma teak had sometimes come in with ends coated with elephant dung! He thought laurel was a hardy timber and would keep very well in transit without any treatment.

Laurel has a Future

My impression is that laurel wood has a future in the British market. Consumption is already going up as the timber is getting to be known. Its chief rival is walnut, but it is said that the supply of Italian walnut which is most favoured in Britain is diminishing. But only the best "figured" logs are worth exporting. English merchants will gladly help us with opinion if we send samples

Acknowledgments

In conclusion, I acknowledge the kind help of Mr. J. N. Oliphant, Director of the Imperial Forestry Institute, Oxford, and of Sir Hugh Watson. I am thankful to the various business firms who helped me with samples and advice.

NOTE BY MR. H. TROTTER, I.F.S., UTILIZATION OFFICER, F.R.I., DEHRA DUN.

Most of the salient points of the above article are well known to shippers of laurel or other woods to England. The European market demands logs of very good quality and large size. It is useless trying to sell small material in England. There is no demand for it and the prices obtained will not pay expenses.

As regards "figure" in laurel, or any other species, it is, as Mr. Sinha says, extremely difficult to detect "figure" in any log. The best that can be done is to try and detect "figure" before exporting, and there are ways of, at any rate, making a shrewd guess as to whether a log contains figured wood or not. One of the best ways is to cut off a few inches from the end or ends of a log, and plane 2 or 3 radial or tangential surfaces on the disc so cut. After planing, apply a little linseed oil. If any good colouring or "figure" is present it will show up clearly. This, of course, is not a sure test that the whole log will be figured, but it will indicate whether there are signs of good coloration or "figure" in the log. Planing and oiling a portion of the sides of the square or log, after the removal of the sapwood, will in the same way indicate whether there is any sign of good coloration or "figure" in the outer layers of the heartwood.

In conclusion, I would strongly recommend end-painting of laurel logs for export. Laurel is a bad splitter and anything that may help to retard rapid drying and consequent splitting is advantageous.

THE CONSERVATION OF PUNJAB WATER SUPPLIES *

By R. Maclagan Gorrie, d.sc., i.f.s.

Normal and Accelerated Erosion.—Those of you who have seen an intensive artillery bombardment probably consider that modern high explosives are the most destructive agent known, but the Punjab contains many square miles of desolation more terrible in its starkness than any battlefield in Flanders. The worst of the old battlefields of Passchendael and the Ancre are once again smiling fields but large parts of the Punjab foothills from Ambala to the Indus are being obliterated more effectively and more permanently by erosion. That this is not a local problem is proved by the ever increasing volume of evidence about the menace of soil erosion and flood damage from other continents. Practically every newspaper nowadays contains some reference to erosion or flood losses either in America, Africa, Australia or Asia. The *Daily Telegraph* of 30th September 1937 had a leader headed "Erosion on Five Continents may mean Food Shortage," so we cannot claim that our local problem is in any way unique. Unfortunately, however, our local conditions do lend themselves to erosion on a gigantic scale because climatic extremes, soft rocks, steep slopes, poor plant cover, a dense population and peculiarly thoughtless and destructive methods of farming all combine to speed up to a fantastic pace the normal processes of geological erosion on our sloping lands. In the study of stream behaviour, floods and silting we ought to try to distinguish wherever possible between the two conceptions of normal geological erosion which is a slow but inevitable process, and the abnormal man-made erosion brought about by the destruction or alteration of the natural plant cover.

Normal geological erosion is very slow indeed. Everywhere except on desert slopes the soil accumulates more rapidly than it disintegrates under the usual natural growth of forest or grassland, and accumulation is therefore generally more active than attrition. Directly this balance is upset, losses increase at the expense of the valuable top soil which is filched away and carried off to the plains and the sea. To appreciate the effect of these changes in terms of

*This paper was read by Dr. Gorrie at the last session of the Punjab Engineering Congress.

run-off control we must know something about the storage of water in the soil. The ideal catchment area is one completely clothed in either forest or grassland, where the natural vegetation has been preserved undisturbed and has been allowed to build up a deep soil profile. The gradations from the living plant cover on top through the humus layer to the mineral subsoil below are blended into one physical unit and this is nature's own provision for efficient disposal of rainfall. The porosity and capacity to absorb surface moisture through any complete natural soil profile is truly amazing.

Value of Plant Cover.—No matter how heavy the rainfall, a very large part of it is delayed by this surface mat of vegetation and passed downwards through the porous layers to the rock cavities and underground storage reservoirs which are the chief support of perennial springs. Anything which interferes with the porosity of the soil or with the healthy condition of the plant cover must inevitably affect the percentage of rainfall which finds its way underground. Of the various factors affecting the plant cover, such as clearing of grassland or forest by burning or felling, ploughing, grazing, etc., grazing is probably the most widespread and most insidious. Constant heavy grazing by underfed animals, such as occurs on village common lands throughout India, leads inevitably to the thinning out of the vegetation and to compacting the soil into a solid mass, so that the reduced cover is less capable of checking surface run-off and the altered soil profile or cross-section is less capable of absorbing it. This phase of soil erosion was discussed by the Punjab Engineering Conference of 1930 when Messrs. Glover and Holland presented a paper on "Erosion in the Punjab Himalaya." The gloomy picture then painted is still accurate, in fact the need for action is now greater because the effects of erosion are cumulative, the vegetation is dwindling and pressure of human and animal population upon the land continues to increase. The only encouraging features are that we now know a little more about the application of control measures, and a start in organising effective control has actually been made in certain very limited areas.

The human population of India is increasing at the rate of three millions per annum and much of this increase is occurring in the drier foothill tracts where the rainfall is not too heavy for the

persistence of natural grasslands. In the heavier rainfall areas further east, the regrowth of dense tropical jungle and conditions inimical for livestock have discouraged settlement. Much pressure is, therefore, bearing upon the *tension belt* where grassland can persist only under reasonable treatment, and if once destroyed, it cannot reassert itself as easily or as quickly as it can under a heavier or better distributed rainfall. Thus it is that in many of the foothill grazing lands of the Punjab and North-West Frontier Province, grassland as such has already disappeared and the huge herds of ravenous village livestock are dependent upon bush growth and tree loppings for their daily ration. In most countries livestock ordinarily have a ration of grass, and the bush growth of the grazing grounds is looked upon as a reserve which should be used only in times of acute shortage. In the Punjab foothills, unfortunately, the last vestiges of shrub growth form the ordinary daily ration of the village herd.

Run-off Data for Grazing Lands.—The amount of erosion and its effect upon the water regime caused by this state of affairs in sloping lands are clearly shown by some data of torrent intensity which have been collected in an arid tract of low hills known as the Pabbi Range which stretches south from the main foothills along the eastern bank of the Jhelum river opposite the cantonment and city of Jhelum. The Pabbi is a low ridge of heavily eroded Siwalik sandstone and shale and shows a variety of conditions of plant cover. The run-off or rather the peak flood discharge for a large number of separate torrents has been collected by the irrigation staff, as they have had considerable difficulty in maintaining the Upper Jhelum Canal in face of these torrents which run at right angles to it and have to be provided with some form of syphon or discharge weir to prevent damage to the canal.

Recognisable cover types in this foothill jungle and the run-off data associated with them are as follows:

(1) Part has been under a regime of afforestation and counter-erosion work for about 50 years; such land, although not fully covered even when fully protected, yields a maximum run-off of less than 100 cusecs per square mile, enables land to be cultivated

close to the streams which drain from it, and yields a revenue of one rupee per acre for grass cutting.

(2) Similar land under a passive regime of protection against grazing but with no active afforestation or building of small bunds in *nalas* yields a maximum of 600 cusecs per square mile.

(3) Similar land under grazing, partially but ineffectively controlled, yields 1,000 cusecs. Its revenue is one anna per acre grazing, and no cultivation is possible within a very wide strip of sandy waste which borders the resulting torrent bed in the flat lands below.

(4) Where persistent cattle and buffalo grazing has destroyed the cover and reduced the area to slopes of shifting sand anchored only by the relics of scrub jungle, the run-off rises to the alarming figure of 1,600 cusecs.

These figures are for small individual catchments of two to ten square miles area, and this last figure, therefore, represents an extremely high percentage of run-off, in the neighbourhood of 90 per cent. of the rainfall for the typical sudden torrential downpour falling on ground previously parched by drought.

Effect of Farm Cultivation on Run-off.—A further serious source of damage to the plant cover which nature originally provided is to be found in the system of field cultivation in the foothills and also in the higher hills up to the level at which summer cultivation is attempted, namely about 10,000 ft. In the lower hills and on gentle slopes the standard of terracing is on the whole fairly good, and in certain tracts, such as the Jhelum Salt Range, the standard in levelling fields is very efficient indeed, either by means of stone walls or ploughed earth scooped up into contour ridges. This, however, is the exception and elsewhere the use and maintenance of *watt-bandi,* the Punjabi equivalent of contour ridging, is sadly neglected or unknown. But effective terracing on slopes is unfortunately confined to the immediate neighbourhood of the homesteads where permanent fields are found. Further afield the lands are roughly ploughed for catch-crops and as the fertility of the soil dwindles the cultivation is abandoned and the lands are left fallow till they have either recovered or have been wasted away. In the hilly and more primitive

tract the steepest hillsides are skinned of their cover, often by burning the forest, and dug by hand because they are too steep to plough. The result is an appalling waste of soil, which is washed away at the rate of as much as 150 or even 200 tons per acre per annum and each field is capable of producing potatoes for only 3 or 4 years, after which it reverts to village grazing. Persistent grazing prevents the re-establishment of the previous forest cover and the ground is eventually reduced to a bare and unstable scree of stones. With this destruction taking place over large areas of tremendously steep country exposed to the terrific onslaught of the monsoon rains, it can be imagined just how serious the effect is likely to be upon the water regime of the country as a whole.

In ploughed fields of course the plant cover provided originally by nature has been removed; in grazing grounds some vegetation still persists, while under forest it has been preserved to a much greater extent though even there the plant cover is subject to much abuse. Wherever destruction or deterioration of the plant cover has taken place, changes in the soil texture also occur. A fully preserved forest or grassland soil shows in its profile, or vertically cut exposed section, a very gradual transition through many grades down to the parent rock below, but these changes are all so gradual that there is no sudden break anywhere in the profile. Such soil with its vegetation is a living entity carefully built up through thousands of years and capable of diverting a large percentage of rain down into the subsoil and the rocks below. Whenever this capacity for absorption is upset, either by forest fires, heavy grazing or clearing for cultivation, less rain is absorbed and the rate at which the water flows over the surface is increased with the natural process of erosion completely altered. It is the quick release of this surface drainage which adds so tremendously to the problems of the water uses in the plains below.

Run-off Data for Foreign Lands.—At Lacrosse, Wisconsin, measurements made by H. F. Scholtz over a three-year period have shown that 20.6 per cent. of all the rain and snow falling on land continuously under maize was lost as run-off. Under a three-year rotation of maize, barley and clover, the same kind of land lost 12.1 per cent. of the total precipitation; but where covered continuously

with grass, only 1.7 per cent. of the water was lost as immediate run-off. These test fields were on a 16 per cent. slope and the average annual rainfall was 34 inches. The soil, a silt loam, was typical of the principal farm land in an area of some 12 million acres in the Central States, and somewhat similar to the rolling uplands and light silty loam of the Jhelum district.

The corresponding losses from the different types of land were as follows: 88.3 tons an acre annually from corn land, 25.3 tons from the rotated area, and only 38 *pounds a year from grassland,* or 4,647 *times less than the loss from corn land.*

On the basis of these measurements, only 11 years would be required, under continuous corn, to remove seven inches of this Wisconsin topsoil, which is about the average depth of the surface soil in the locality. To wash away an equivalent depth of soil from the field in rotation would require 40 years and for grass 53,000 years. The exceedingly slow rate of erosion taking place under grass (normal or geological erosion) probably means that the soil is stabilized, that is to say, soil under good plant cover builds from beneath faster than it is removed from the surface.

In view of the small loss of rain water from land having a good vegetative cover, together with the greatly reduced water losses where cropping practices are supported by protective strips of vegetation and by other adaptable control measures, such as terracing and *watt-bandi,* the farmer who tries to save and protect his soil contributes substantially to the prevention and control of floods.

Types of Erosion Damage—(*a*) *Sheet washing plugs soil pores*—The first effect of releasing a larger surface flow is for soil particles to be swept along and carried over the surface of the ground, or even when the ground is practically level, rain water gains some momentum while running off a bare surface. The effect of this is that the natural pores or spaces in the soil become clogged up with this sediment which is being washed along. This immediately interferes with further seepage or percolation by the soil. By introducing 2 per cent. of sediment into water and making this mixture percolate through a soil surface, Lowdermilk has shown that *the rate of percolation falls off 90 per cent. in six hours as compared with clear water; and reverting to the use of clear water does not accelerate it afresh.*

This plugging acts as if a paste were spread over the ground surface, sealing up pores and spaces. Thus silt-laden water has a disastrous effect in reducing the amount of seepage, so that more water is forced into the paths of surface drainage. It is only recently that Lowdermilk's work has given us exact information about this very important sealing effect of silt-charged run-off water.

The next thing that happens further down the slope is a sort of sand-papering action, because silt-laden water rubs away the floor and sides of the channels in which it flows. In an open field these channels form a fine network of "finger gullies" only a fraction of an inch deep, and in each of these fresh soil is abraded and swept away. The effect over the whole field is to carry away a thin skin of soil from the whole surface, and this is known as "Sheet Washing."

When this has occurred on a field, ploughing immediately hides all traces of this network of finger gullies, so that the process is not as commonly recognised as it ought to be. When it occurs on grazing ground, it is checked to some extent by the mat of the plant cover, but on the other hand nothing is done to fill the finger gullies up, and so they go on cutting deeper.

(*b*) *Soil is Early Robbed of its Valuable Chemicals.*—In addition to robbing the top-soil by the mechanical removal of soil particles, accelerated erosion has been proved to remove a relatively greater amount of soluble chemicals which are vital to the plant—in other words it robs the still undisturbed soil of its best chemical properties before it actually washes it away. This has been proved repeatedly by growing wheat and other plants in pots containing soil from eroded and uneroded spots from the same field: the plants in the eroded soil are always much poorer. As an example of the value of top-soil lost the following figures from Rhodesia are very convincing:

	Soil loss tons per acre.	Depth of soil eroded in inches.
Unprotected land	... 30	0.2052
Protected by contour ridge sloped 1 in 400	... 0.91	0.0062
Protected by a contour ridge sloped 1 in 1,000	... 0.67	0.0046

Large run-off and soil tanks were made to catch the entire run-off from these 2 contour ridges, draining areas 5.59 and 4.69 acres. The loss of plant food material was 2 to 4 lbs. per acre as compared with 70 to 126 lbs. per acre from the unprotected land. The value of the potassium, phosphorus, calcium and nitrogen thus lost in one year was £4-12-0 per acre from the unprotected soil.

Waksman has shown that the soil which is left behind after erosion is also poorer in the micro-organisms which are so important for the proper development and function of roots.

(*c*) *Gullying destroys Subsoil Moisture Reserve.*—When these finger gullies are allowed to deepen, the next stage of deeper gullies comes on, and clefts are formed which bite down through the top-soil to the subsoil. This may be more easily eroded than the top-soil, and if it is, the surface is very soon cut up into blocks separated from each other by ever deepening gullies. Not only is cultivation rendered difficult by these obstacles; the ground is also artificially drained to a greater extent than formerly, so that the blocks of soil that are left are much drier and less productive. Similarly, in grazing land or in forest where deep gullies are allowed to form, the previous moisture balance is upset and the existing plants can no longer remain healthy because the moisture ration has been reduced. In the case of deep rooting trees such as oaks, the old crop will persist for sometime but the regeneration of young trees to take their place will be prevented by lack of moisture, and so the crop inevitably dies out.

Effect of Single Heavy Storm.—Deep gullies are often formed as a result of one phenomenal storm of sustained and heavy downpour falling on land which has been unduly exposed by misuse in the past. Once these gullies have been cut out, the ground can never return to its former productive capacity because the whole drainage regime has been changed. It is not the average rainfall that does most damage, but a single infrequent but exceeding heavy storm which by cutting out fresh gullies starts a new cycle of erosion. Many local instances of this could be quoted for September 1924, in the Eastern Punjab hills and for August 1929, in the North-West Frontier Province. Examples of actual erosion measurements for single storms are given in the table on the next page.

WATER AND SOIL LOSSES FROM RAINS OF RECORD INTENSITY AT FIVE SOIL AND WATER CONSERVATION EXPERIMENT STATIONS.

Station.	Date of Rain.	Rainfall.		Intensity.		Cover.	Slope.	Run-off.	Soil Loss.
		Amount	Duration.	Actual Rate.	Max. Rate.				
		Inches.	Hours.		Inches. per hour.		Per cent.	Per cent. precipitation.	Tons per acre.
(Tyler, Texas fine sandy loam).	May 8 and 10, 1936.	4·7 5·13	9·17	1·08 inches in 5 minutes.	12·96	Bare .. Grass .. Forest ..	8·8 16·5 12·5	34·92 ·35 ·36	44·49 None ·010
(Guthrie, Oklahoma fine sandy loam).	May 31, 1932	3·04 3·04 2·81	10	1·5 inches in 20 minutes.	4·5	Bare .. Grass .. Forest ..	7·7 7·7 5·2	53·06 2·30 0·26	2·59 ·015 ·005
(Hays, Kansas silt loam.)	August 1, 1932	1·50	·66	1·4 inches in 20 minutes.	4·2	Bare .. Grass ..	5·0 5·0	59·2 1·2	4·07 ·01
(Bethany, Mo. silt loam).	April 3, 1934	3·75	9·25	2·85 inches in 90 minutes.	1·90	Bare .. Grass ..	8·0 8·0	52·7 39·2	28·50 ·09

General Increase in Drought Damage and its Cause.—Frequent references are to be found in Revenue Settlement Revisions in both the Punjab and the North-West Frontier Province (*e.g.*, Mansehra Tahsil) which indicate very clearly that there is a progressive desiccation being experienced in cultivated lands. This deterioration is widely distributed throughout all the *barani* lands (bearing rain-fed crops), but naturally one would not expect it to be noticeable in the larger canal colonies. Even in these, however, the shortage of winter water for *rabi* crops is a common complaint, except in those relatively small areas which are actually suffering from water-logging through a cumulative rise in the subsoil water table. Our chief concern is with the rest of the farm tracts which are not irrigated except from small local streams or by well. In these the increase in drought damage is too great to be explained by minor changes in the climatic cycle. The increase is undoubtedly due to the growing inability of the soil to retain whatever moisture falls upon it, because through erosion the wasted top-soil is being replaced by the less absorptive clay which usually forms the subsoil. This cumulative failure of the soil itself to soak up and retain rain water is of far more importance in causing drought than any minor changes in the actual amount of rainfall, though its importance has not yet been grasped by either zamindars or officials. Its effect is most evident in *barani* lands which are directly dependent upon the storage of a part of the rain which falls upon them, but indirectly, though no less surely, it must affect well levels or *chahi* irrigation and also the winter level of small streams which depend upon springs and underground seepage of water for their winter flow. This failure to absorb and pass downwards a share of the surface run-off should be felt least of all in the larger rivers which depend upon the great snow-fields and glaciers for most of their supplies, so that the big canal colonies are least likely to be affected, but even in these big rivers *the winter flow* depends to a great extent upon the subsoil drainage which reaches their foothill tributaries, and so they too are bound to deteriorate in their winter flow owing to the widespread desiccation in the foothills. Drought damage is often regarded as being an inevitable scourge, particularly amongst the fatalistic Punjab peasantry. Actually a well directed programme of water conservation would do a great deal towards improving the position both of the unirrigated tracts and of the

rabi supplies for the canal colonies. In the unirrigated parts of the province the most pressing water supply problems are in the semi-arid northern districts where the rainfall is uncertain, though the problem occurs in some form throughout the Punjab. Where the Forest Department has had full control their areas form the sole examples of effective conservation but unfortunately the department has no control over common grazing lands.

Winter Run-off Localised in Uhl Catchment Area.—The Punjab run-off problem was discussed at the 1937 meeting of the International Commission of Snow, by Dr. J. E. Church, the President of that body. He drew a detailed comparison between the Californian Sierra and the Punjab Himalayas as regards topography, climate, latitude, temperatures, storm seasons and snow-fall, and showed that in both countries the ground above the 9,000 feet contour contributes practically nothing to the winter run-off. The higher ground is frozen under its mantle of snow during the winter months and seepage from the snow itself is small. The main winter supply therefore must come from the foothills and lower slopes of the main range below the 9,000 foot line and as the majority of this is not under forest but is either cultivated or heavily grazed, the lack of an efficient water-conserving plant cover is likely to be seriously felt in dwindling nadir flow each winter.

This prognostication from a well known outside authority is borne out by our own experience. From the changing colour of the water in the Kangra streams we know that winter rain or snowfall carries practically no silt from the higher ground, but a heavy silt load from the lower slopes. A recent survey of erosion conditions in the Uhl Valley which supplies the Mandi Hydro-Electric Plant showed that the extremely low nadir flow in January each year is directly traceable to the appalling condition of the valley bottom betwen 6,000 and 9,000 ft., where 55 per cent. of the 21,000 acre farm belt is eroding seriously as a result of potato farming on unterraced ground and over-stocking of the grazing grounds. To appreciate the effect of a good plant cover in vitally important catchment areas such as the Uhl, let me quote figures of run-off losses from the Susquehanna river basin in New York State for March 1936. This catchment is not nearly as steep as the Uhl but the method of potato farming and the types of natural plant cover on uncultivated ground

are somewhat similar. The loss of water as immediate run-off from a potato field was 88 per cent. of the total precipitation, on land having a slope of 14 per cent. Of 9.47 inches of rain and snow, 8.38 inches was lost as run-off during this critical period. In contrast the corresponding loss of water from a neighbouring forested area having a 27 per cent. slope was approximately 0.5 per cent. of this total precipitation which included both the rain and the snow that had accumulated before the rain. It is interesting that the ground beneath the cover of forest litter was not frozen, whereas that in the potato field was frozen. Still more surprising was the fact that from the neighbouring grassland, with a slope of 20 per cent., the run-off was less than 0.2 per cent. of the total precipitation, and there was no measurable erosion. In this last instance, the ground was not frozen.

Recommendations for Action in Uhl Catchment.—These figures may give you some idea of what I believe to be happening in the Uhl Valley. On the basis of my detailed survey of the Uhl catchment I have recommended to the Punjab Government that drastic action should be taken against the two main evils of bad farming methods and over-grazing. A committee has been formed and its report is still *sub judice*. Some action has already been taken to control the migrant flocks of goats and sheep, but nothing has yet been done to improve the cultivation, which is in this case the greater evil. My proposals which are still under consideration by the Punjab Government were that the worst unterraced fields be acquired, taken out of cultivation, and planted up under a reforestation scheme in which individual blocks will have a minimum area of about 50 acres per block so as to make fencing reasonably cheap.

From a prolonged study of this subject in many lands I feel sure that the immediate afforestation of one-third of the Uhl farm belt and an improved farming regime in the remainder of it would have the effect of raising the winter nadir flow by 500 per cent., *i.e.,* that instead of the present nadir of 80 cusecs you would have a guaranteed minimum of 400 cusecs, no matter what might be the vagaries of the winter climate. It would, of course, take a few years for any such afforested area to develop its full value as a run-off control, so the sooner the work is started the better. Acquisition and planting of 7,000 acres on a ten-year programme would cost roughly Rs. 3,50,000 or including propaganda and demonstration of better farming practices, say four lakhs. This seems a small amount to spend as an insurance against deterioration and calamities which are inevitable unless some such action is taken. The amount of money already invested in the Uhl project is eight crores so that those 150

square miles of mountain fastness carry an investment value of Rs. 830 per acre if you include the whole area, or nearly Rs. 4,000 per acre if spread on the land yielding the winter run-off. The present revenue obtained by Government from the farming and grazing community amounts to one-quarter anna per acre. These figures show strikingly how much more valuable this land is for water conservation than for any other purpose. One can only marvel at the sublime faith of the engineers who planned such a project and based all their calculations on a stable water regime when actually the water conservation is each year becoming worse, and the water regime is very far from being stable.

Recommendations for Rest of Foothill Districts.—These recommendations for the Uhl catchment are admittedly drastic and expensive, but they are framed to save a small area which is of particular and vital value for the whole province. In the rest of the province we cannot afford large expenditure, and improvement can come only in so far as we can teach the villagers to take up conservation work themselves. Great credit is due to the Punjab Government for having got ahead in Hoshiarpur and more recently in Jhelum with encouraging wholesale closure of eroding slopes by persuading the villagers to substitute grazing with grass cutting. The point I wish to impress upon this conference is that there are really vast possibilities for improving water conservation everywhere without incurring any very heavy expenditure. The main lines of attack can be combined under the American's name of "upstream engineering" which combines the botanical and land management phases in producing a better plant cover, along with elementary engineering practice in building series of low bunds in each stream bed to delay and spread out the actual run-off peak, and stop further erosion of the stream bed itself.

Improvement lies in a well considered programme for better farming practices to conserve run-off on all cultivated ground; better control of livestock to prevent overgrazing and conserve the soil cover; check dams and water-catching projects in all the smaller *nalas* which drain the upland grazing grounds and forests in each small catchment area. Droughts are merely the troughs or low supply periods between floods, and any work that is undertaken to check and reduce the intensity of floods will naturally have the effect of smoothing out the curve of seasonal supply and eliminating the troughs of severe water shortage. The simpler the engineering and the closer the attention to run-off conditions in the head of each small catchment where percolation helps underground storage, the better will be the results in eliminating the drought bogey.

TIMBER PRICE LIST FOR SEPTEMBER-OCTOBER 1938
(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing	*Tetrameles nudiflora*	Assam	Logs	Rs. 30-0-0 per ton in Calcutta.
Benteak	*Lagerstrœmia lanceolata*	Bombay	Squares	Rs. 36-0-0 to 80-0-0 per ton.
,,	,,	Madras	Logs	Rs. 1-4-0 per c.ft.
Bijasal	*Pterocarpus marsupium*	Bombay	Logs	Rs. 42-0-0 to 84-0-0 per ton.
,,	,,	Madras	Logs	Rs. 0-15-7 to 1-3-3 per c.ft.
,,	,,	Orissa	Logs	Rs. 0-8-0 to 1-4-0 per c. ft.
Blue pine	*Pinus excelsa*	N. W. F. P.	12′×10″×5″	Rs. 4-4-0 per piece.
,,	,,	Punjab	12′×10″×5″	Rs. 4-10-0 per piece.
Chir	*Pinus longifolia*	N. W. F. P.	9′×10″×5″	Rs. 1-11-0 per piece.
,,	,,	Punjab	9′×10″×5″	
,,	,,	U. P.	9′×10″×5″	Rs. 3-4-0 per sleeper.
Civit	*Swintonia floribunda*	Bengal	Logs	
Deodar	*Cedrus deodara*	Jhelum	Logs	
,,	,,	Punjab	9′×10″×5″	Rs. 3-12-0 per piece.
Dhupa	*Vateria indica*	Madras	Logs	
Fir	*Abies & Picea* spp.	Punjab	9′×10″×5″	
Gamari	*Gmelina arborea*	Orissa	Logs	Rs. 0-10-0 to 1-4-0 per c.ft.
Gurjan	*Dipterocarpus* spp.	Andamans	Squares	
,,	,,	Assam	Squares	Rs. 50-0-0 per ton.
,,	,,	Bengal	Logs	Rs. 30-0-0 to 35-0-0 per ton.
Haldu	*Adina cordifolia*	Assam	Squares	Rs. 1-4-0 per c.ft.
,,	,,	Bombay	Squares	Rs. 24-0-0 to 68-0-0 per ton.
,,	,,	C. P.	Squares	Rs. 0-13-0 per c.ft.
,,	,,	Madras	Logs	Rs. 1-3-0 per c.ft.
,,	,,	Orissa	Logs	Rs. 0-5-0 to 0-9-0 per c.ft.
Hopea	*Hopea parviflora*	Madras	B. G. Sleepers	Rs. 6-0-0 each.
Indian rosewood	*Dalbergia latifolia*	Bombay	Logs	Rs. 52-0-0 to 100-0-0 per ton.
,,	,,	C. P.	Logs	Rs. 1-2-0 per c.ft.
,,	,,	Orissa	Logs	Rs. 0-12-0 to 1-4-0 per c.ft.
,,	,,	Madras	Logs	Rs. 2-2-5 to 3-12-0 per c.ft.
Irul	*Xylia xylocarpa*	Madras	B. G. Sleepers	Rs. 6-0-0 each.
Kindal	*Terminalia paniculata*	Madras	Logs	Rs. 1-4-0 to 1-5-6 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 36-0-0 to 72-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-12-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-12-1 to 0-14-2 per c.ft.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	Rs. 1-2-9 to 3-14-0 per piece.
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 25-0-0 to 75-0-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 5-4-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 20-0-0 to 75-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Rs. 0-8-0 to 1-3-0 per c.ft.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 to 5-0-0 per sleeper.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 1-10-0 per sleeper.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-4-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-0-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-14-3 to 5-4-0 per sleeper.
Sandalwood ..	*Santalum album* ..	Madras ..	Billets ..	Rs. 306-0-0 to 639-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Rs. 1-8-0 to 1-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-0-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 31-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	Rs. 1-0-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Rs. 0-12-1 to 1-1-10 per piece.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 0-14-0 to 1-6-6 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class	
,, ..	,, ..	,, ..	Logs 2nd class	
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-9-9 per c.ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 2-3-3 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-9-3 to 2-7-0 per c.ft.
,, ..	,, ..	Bombay ..	Logs ..	Rs. 68-0-0 to 140-0-0 per ton.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 3-14-0 each.
White dhup ..	*Canarium euphyllum* ..	Andamans ..	Logs ..	

EXTRACTS

SOIL EROSION PROBLEMS IN INDIA

Soil Erosion, its Causes and Cure

(By E. A. Smythies, Chief Conservator of Forests and Chairman, Fodder and Grazing Committee.)

Geologists tell us that in the dim past, before life and vegetation had started on earth, the surface crust was exposed to the full forces of disintegration, the sun, frost, rain and wind, resulting in tremendous erosion, denudation and deposition. But during aeons of time, mother earth gradually covered her nakedness with a protective covering or blanket of vegetation, which, starting on the shores of seas or lakes, during the course of untold centuries, spread over the land surfaces, and as it spread, sheltered the rocks and the soil from the fury of the elements, and greatly mitigated the disintegrating influence of erosion.

CAUSES OF EROSION

During the last few thousand years, however, the evolution of Man, and the increase of his activities over the habitable Globe, have created an agency capable of profoundly affecting the perpetual war between the elements of destruction and of protection, and unleashing once more the full forces of disintegration "as it was in the beginning." Many years ago it had been clearly proved and recognised as a universal phenomenon that destruction of forest growth in mountain country, without compensation such as terracing and regular cultivation, led to a tremendous increase of erosion, avalanches, destructive floods, drying up of water springs, overburdening the rivers with silt and boulders. Where the rivers debouched on the plains, this burden of detritus is deposited far and wide over fertile cultivation, wiping out whole villages and towns, silting up canals, and even mighty Empires have crumbled before the irresistible advance of man-made deserts and sheet erosion. Thus the change of the once fertile lands of Mesopotamia into desert has been ascribed by many authorities to the destruction of the natural vegetation by man and his cattle, while the ruination of hundreds of villages in the Hoshiarpur district of the Punjab, due to the destruction of forests in the adjoining hills, is a well known example in India.

Of recent years, however, it has been recognised that the destruction (by man) of the natural vegetation of comparatively flat lands can also set free enormous forces of erosion. To quote Professor Stebbing:

SOIL EROSION DUE TO OVER-CULTIVATION AND EXCESSIVE PASTURAGE

"This form of erosion is in its action very similar to Sheet Erosion, but it is confined to more or less level plains country. The top-soil from repeated cultivation coupled with exposure to a hot sun and strong, probably hot, winds, disintegrates *sur place* and assumes the form of dust which is blown away in clouds. It is probable from the modern examples now in process of formation, that this is one of the methods, if not the principal method, by which the more level portions of some of the large deserts of the Globe were brought into being, probably with the assistance of excessive pasturage by stock. With the disposal of the top-soil the area loses its fresh fertility;

subsequent continued cropping of the soil leading to increasing impoverishment of the soil layers capable of production, the drying up of water supplies and lowering of the water table, decrease in rainfall, with the final formation of a desert.

MODERN DAY EXAMPLES

Modern day notable examples in process of formation:

"In the United States millions of acres of land in the North-Central and North-Western States as well as in parts of the South, have been affected in this way by the over-utilization of the soil in the production of wheat and cotton, in what is known as the Dust Bowl. This has not only impoverished large numbers of farms but still threatens to engulf a larger area of the fertile country in the immediate vicinity of the outer periphery of the Dust Bowl. The recent (1937) great floods in the Mississippi may, in part, have been assisted by the run-off from the ruined prairie lands to the west of the river, turned into a desert bowl by over-cropping.

"Canada, in the prairie provinces of Saskatchewan and Alberta, has the same story to tell.

"In Africa much of the desert-forming country round Gao, in the French Sudan Colony, and away to the north towards Tabankort and westwards, into the present Mauretanian desert (all in the Western Sahara), a highly-populated area a few centuries ago, must have started on the downward grade by over-cultivation combined with firing the countryside.

"For a long period the state of affairs resulting from over-grazing has been known in India and examples of damage and loss can be found all over India. In South Australia, millions of acres of a countryside, which a few decades ago carried sheep, are now desert."

GREAT DANGERS TO MANKIND

The examples, from all over the world, will suffice to show the great dangers to mankind inherent in over-cultivation and over-pasturage. And nowhere is the danger more real than in the intensively cultivated and highly populated plains of the United Provinces. It is true that the wave of creeping desert conditions, that perpetually threatens the United Provinces from the west, is being perpetually fought back over large areas by the great canals and tube-wells and irrigation works generally, but there are precarious tracts without irrigation facilities, in Muttra, Agra, and the western districts.

A Capital Loss

Consider again the enormous loss of good fertile soil to the province by gulley or ravine erosion, evidence of which can be seen on the over-grazed banks of almost every river and stream in the plains districts. In the Jumna-Chambal basin, for example, between a quarter and a half million acres of land have had 20 to 40 feet depth of soil eroded. *This represents the loss of a perpetual stream of soil, never stopping for an instant day or night, removing over 12 cusecs or half a ton per second for the past 1,000 years.*

Once the soil has been washed away, it is a capital loss that nothing can replace.

Blown Sand

Another type of soil infertility and destruction is blown sand. The classic example occurred on the western shores of France, where sea sand from the Biscay Coast perpetually encroached on villages and cultivated lands, until the French with ingenuity and patience, about a century ago, built up an impenetrable barrier of grass and pine forest to the invading sand, and converted the sandy wastes into valuable plantations. At the present day the Sahara desert is progressing southwards a mile a year, due largely to the destruction of vegetation (by over-cultivation and over-grazing) in front of it. In the United Provinces, the infertile *bhur* lands are examples largely of blown sand, which, as Khan Bahadur Wahiduddin of Meerut has proved on a small scale, can be successfully controlled and converted into useful plantations.

Fundamental Cause

I have endeavoured to show that the fundamental cause of soil erosion in its various forms is the removal and destruction of the natural vegetation which the earth has provided to protect its surface from the forces of disintegration, sun, frost, rain and wind. The protective vegetation is not necessarily forest, it may be the grasses and herbs of the prairies, or the shrubs and thorny bushes of Africa or the Jumna ravines.

The Cure

Knowing the cause, the *cure* is self-evident; if the natural vegetation is allowed to grow again, the erosion will cease. It is neither possible nor necessary to aim at natural vegetation in cultivated

lands, since double-cropping, or crops like sugarcane, keep the soil protected for most of the year. But the uncultivated lands of the United Provinces are a glaring example of the inefficient utilization, resulting in erosion. *Experiments carried out by the Forest Department during the past 25 years in the Jumna-Chambal ravines and elsewhere have proved conclusively that control of grazing alone is sufficient to bring back the natural vegetation and check further erosion.*

To quote from a recent article in the *Statesman*:

"Planning on a wide scale to maintain soil fertility is of supreme importance to this country in her campaign of rural reconstruction." Is it fair or right for an individual or community to mismanage a tract of land so that the property of a neighbour is endangered, whether by ravine erosion or wind-blown sand or otherwise? Is it sound planning to allow many millions of tons of soil to be washed away every year, and lost to the Province for ever, without making any attempt to prevent it, when both the cause and, to an appreciable extent, the cure are known? Is it not the duty of Government to prevent the misuse of land in the interests of the nation?

In the forthcoming Rural Development Act, public opinion should urge the Government to acquire powers to check the uneconomic use, and general neglect, of waste lands of the Province, which means in effect to discourage the appalling over-grazing that is the fundamental cause of their deterioration and destruction, and encourage stall-feeding and growing of more fodder crops.

Similarly, there should be powers to check shifting sand dunes and put *bhur* land to a more economic use. If legislation to protect generally the soil fertility of waste lands is introduced in the United Provinces, such legislation will indeed be an act of bold and far-sighted statesmanship, and a lead to other provinces.—(*Reproduced from the Public Information, U.P., for June* 1938).

YERBA DE LA PULGA PLANT

Recently the Pan-American Society of Tropical Research notified us that they have been successful in bringing back to this country nearly three million seeds of the species of plant known by its native

name as "Yerba de la Pulga." Extensive experiments and observations indicate that this plant possesses exceptional insect-repelling qualities, and it is the Society's belief that the plant does not only contain, but actually exudes, sufficient quantities of the drug "rotenone" to make a single growing specimen of the plant repellent to practically all forms of insect life in an area of some 15 to 20 square feet.

Since the Society desires to distribute these seeds to all who wish to experiment, they have asked us to say that they will send a small package to all readers requesting them between July 1st and August 1st, provided a stamped self-addressed return envelope is enclosed with the request. The Society states that there is absolutely no obligation attached to this offer.

Anyone wishing to co-operate in this experiment may do so by sending the stamped envelope as requested to the Pan-American Society of Tropical Research, Post Office Box 1698, New Orleans, Louisiana.—(*Scientific American,* July 1938, page 33.)

CULTIVATION OF BAIB

By M. D. Chaturvedi, Development Officer, Forests.

Description

*The baib**—*Pollinidium binatum (Retz.)* C. E. Hubbard—is a perennial grass. About 4 to 5 feet in height, the stems are tufted, erect, slender, grooved, shiny and woolly at the base. It branches sparingly. Leaves: 3 to 4 feet by 1/10th of an inch, tapering, concave and base obtuse. Flowers: racemes 2—4 on axillary and terminal thread-like pendundcles, about an inch to 2 inches long, erect and golden in colour.

Silvicultural Characters

2. In its natural habitat, the *baib* grass occurs freely along steep slopes on dry stiff soils where nothing else grows. The upper reaches of the Siwalik ridges and crags, where moisture is deficient, support little else but *baib*. The secret of *baib* lies in its thrifty nature. On rich soils it cannot withstand the competition of other grasses, and is rapidly swamped. It has therefore adapted itself

* The *baib* is also known as *bhabar* and *sabai, Syn. Pollinidium angustifolium Ischaemum angustifolium* ; *Andropogon binatus.*

to localities where adverse conditions of growth render the invasion of other grasses impossible. Thus, *baib* thrives even on the poorest soils and is hardy both to frost and drought. In the blanks of the South Kheri Division, which are perhaps the worst frost holes in these provinces, *baib* grows luxuriantly. It adapts itself to sandy soils (*bhur*) in the plains and is about the only species which is comparatively unaffected by failure of the monsoon. It is unmindful of an occasional fire and as a matter of fact burning seems to accentuate rather than retard its growth. The only adverse factors which militate against its growth are water-logging, heavy clay soils, weeds and overhead shade.

SEED

3. The *baib* flowers during March-April and the seed is ready by May-June. Another crop of seed is produced after the rains. The seed, black in colour, is exceedingly minute and light.

PROPAGATION

4. The *baib* is best propagated vegetatively by root stocks which can be either collected from the adjoining forest or taken out from a nursery. The lead of root stocks to most plains areas involves prohibitive transport costs. It is therefore recommended to raise local stock by seed in nurseries.

NURSERY TECHNIQUE

5. The nursery site should be well-drained and accessible. The *baib* thrives best on sandy loams and loamy sands, commonly known as better types of *bhur* soils. The nursery should be dug about a foot deep and the soil allowed to weather for some time. It should then be thoroughly broken up and worked. All roots and tufts of grasses should be collected and carefully burnt. With the break of the monsoon (or the commencement of irrigation) all extraneous grass seeds lying in the soil should germinate within a fortnight. These grasses should then be systematically pulled out and removed. The soil should be levelled and the *baib* seed admixed with sand should be lightly sown. Wait for a break in the monsoon for the sowing of seed, otherwise it is apt to be washed away. Keep nursery beds weeded clear throughout the rains. As a matter of fact, very little weeding will be necessary if all extraneous grasses are carefully pulled out and eliminated before sowing.

PLANTATION

6. (*i*) *Site.*—Well-drained sandy loam areas are eminently suited to the cultivation of *baib*. Water-logging and overhead shade check its growth and must be avoided.

7. (*ii*) *Soil preparation.*—The soil should be thoroughly ploughed up and worked sometimes in April and allowed to weather through the summer. All grass tufts and vegetable matter should be dug out and carefully burnt. At the break of rains, wait for a fortnight or so, until the grass seeds and roots, still lying in the area, germinate. These should be systematically pulled out and eradicated. The soil should be ploughed up once again and levelled.

8. (*iii*) *Planting.*—*Baib* from nurseries should now be put out 2 feet by 2 feet.* All that is needed is to introduce small tufts with roots into planting holes made at the time of planting with a spade. The soil when filled back in holes should be tightly packed around the tufts and finished slightly higher than the ground level to avoid water-logging.

9. (*iv*) *Weeding.*—The secret of *baib* cultivation lies in clean weeding. Left to itself, *baib* is unable to compete with other grasses, and it is for this reason that it has been driven to most inhospitable tracts. A systematic rooting out of all grasses before planting especially *kans* and spear grass makes subsequent weeding less intense and frequent. Two weedings during the rains will generally suffice. In subsequent years a thorough weeding immediately before each cutting is all that is required.

10. (*v*) *Protection* (*a*) *Animals.*—Young fresh shoots of *baib* are readily eaten by wild animals and also by cattle. At a later stage it is not generally eaten. It is liable to damage by pigs, porcupines and white ants.

11. (*b*) *Fire.*—No precautions against fire are necessary. As a matter of fact experience in Bihar indicates that it is beneficial to the growth of *baib* to burn the area in May (2nd year) and repeat the burning every year.

* In the South Kheri Division, Mr. Bansal tried various distances at which *baib* was spaced. The best results were obtained with 2×2 feet. The yield fell with a closer spacing, while a wider spacing led to the invasion of grasses.

RATE OF GROWTH

12. By the end of October, *baib* reaches a height of about $1\frac{1}{2}$ to 2 feet. The grass is ready for cutting by the middle of the following July, *i.e.*, when it is about 12 months old. It yields a second crop again during November-December.

13. The yield varies with the soil. In the South Kheri Division the average yield of both crops is about 40 maunds per acre. At Ujhani in Budaun District on *bhur* soil with a spacing of 3 feet × 3 feet the yield has averaged about 20 maunds per acre.

FINANCIAL RETURNS

14. (*a*) *Expenditure*.—Figures of cost of soil working and weeding are available only under forest conditions, where labour is scarce and hoeing has to be resorted to instead of ploughing. The South Kheri plantations cost as under:

	Per acre Rs.
1st hoeing (April)	12
2nd hoeing (June)	8
Collection of root stocks	8
Planting	12
Weeding costs (2)	10
Incidental charges	10
Total Expenditure ...	60

15. (*b*) *Income*.—The following year the grass is ready for cutting. The average yield with proper attention should be about one ton per acre. *Baib* in South Kheri is sold for about 12 annas per maund. In view of the proposed extensive cultivation of *baib* and consequent increase in future supplies, it should be safe to assume the price of *baib* as 8 annas a maund, so producing an income of about Rs. 13-8 per acre.

ECONOMICS OF BHUR SOILS

16. Vast stretches of *bhur* soils in these provinces at present support little else beyond patchy and precarious cultivation and *munj* (*Saccharum munja*) grass. The income from these lands under the best of circumstances does not exceed Rs. 5 an acre. The cultivation of *baib* in *bhur* soils should secure a steady income of Rs. 13-8 per acre. With plentiful supply of cheap labour and bullock

ploughing the cultivation of *baib* under village conditions would naturally cost very much less than under forest conditions.

MARKETS

17. (*i*) *The ban industry.*—The *baib* is used as a cheap alternative to *munj* for *ban* and rope making and competes favourably in cheap markets, the *baib* products being about 40 per cent. cheaper. While the *munj* occurs freely on most *bhur* soils, the *baib* has largely to be imported from the forests. No information exists regarding the actual and potential demand for *baib* for the *ban* industry in these provinces. The Siwaliks supply about 30 to 35,000 maunds of *baib* to the Meerut Division. The scope for the *baib* cultivation for the *ban* industry seems to consist in replacing the *baib* at present imported from the forests by that grown cheaper locally.

18. (*ii*) *Paper manufacture.*—The main use to which *baib* is put is for the manufacture of paper. *Munj* cannot be employed for this purpose. Till recently, the *baib* raised in the forest areas of these provinces was largely supplied to the paper mills at Lucknow and at Titaghar, near Calcutta. With the reopening of the Jagadhari Mills, and the erection of a new mill at Saharanpur and another in Bihar, the demand for *baib* now greatly exceeds the supply from the forests of these provinces. The Saharanpur plant has been specially designed for extension in accordance with the increase in the supply of *baib*. There are also other paper mills to be started shortly within easy access of these Provinces. In view of recent development in the paper industry, a reasonable increase in *baib* supply will find a ready market. But, taking a warning from the sugar industry, it is necessary to emphasise that the demand both existing and potential is not unlimited and an increase of *baib* cultivation to about 30 or 40 square miles in all probably represents the maximum expansion that would be economically justified.—(*Reprinted from U. P. Forest Department Leaflet No.* 9 *of June* 1938.)

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for August 1938:

IMPORTS

ARTICLES	MONTH OF AUGUST					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
Siam ..	31	23	18	4,586	4,248	1,603
Burma ..	..	11,376	11,323	..	14,50,219	15,31,774
French Indo-China	40	141	118	5,622	14,953	17,578
Java .	465	1,121	283	56,227	1,36,732	32,558
Other countries ..	1	25	..	93	2,711	..
Total ..	537	12,686	11,742	66,528	16,08,863	15,83,513
Other than Teak—						
Softwoods ..	3,283	1,749	1,034	2,02,919	1,34,140	73,382
Matchwoods ..	877	566	658	45,595	37,984	47,236
Unspecified (value)	..	..	..	28,112	91,180	2,15,263
Firewood ..	38	49	60	578	735	904
Sandalwood ..	7	..	..	1,722	..	..
Total value ..	..	..	..	2,78,926	2,64,039	3,36,785
Total value of Wood and Timber ..	..	..	..	3,45,454	18,72,902	19,20,298
Manufactures of Wood and Timber—						
Furniture and cabinetware ..	No data			No data		
Sleepers of wood ..	..	160	..	..	24,934	90
Plywood ..	191	515	241	43,601	1,06,299	58,008
Other manufactures of wood (value) ..	..	..	..	1,02,295	1,62,257	1,31,113
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	1,45,896	2,93,490	1,89,211
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	17,891	9,006	22,926	1,18,877	62,088	2,14,784

EXPORTS

ARTICLES	MONTH OF AUGUST					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	3,904	35	2	7,88,571	4,600	375
,, Germany ..	393	..	..	91,537	..	..
,, Iraq ..	89	15	32	15,297	4,808	7,647
,, Ceylon ..	98	1	..	11,496	100	..
,, Union of South Africa ..	387	..	..	68,283	..	..
,, Portuguese East Africa ..	9,880	..	..	1,18,115	..	..
,, United States of America ..	..	..	..	..	..	..
,, Other countries	449	56	262	93,669	17,530	91,181
Total ..	5,379	107	296	10,78,733	27,038	99,203
Teak keys (tons) ..	400	..	..	56,150	..	..
Hardwoods other than teak ..	235	..	..	23,914	..	..
Unspecified (value)	..	..	..	64,827	23,077	14,540
Firewood ..	..	..	..	..	..	..
Total value ..	..	..	..	1,44,891	23,077	14,540
Sandalwood—						
To United Kingdom	1	4	..	1,000	4,000	..
,, Japan ..	..	7	18	..	6,800	19,800
,, United States of America ..	72	51	..	99,048	50,800	..
,, Other countries	20	22	12	23,409	20,145	10,662
Total ..	93	84	30	1,23,457	81,745	30,462
Total value of Wood and Timber ..	..	..	..	13,47,081	1,31,860	1,44,205
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	2,614	25,229	38,481
Other Products of Wood and Timber	No data			No data		

DOMESTIC OCCURRENCES

BIRTH.—To Winifred, wife of A. L. Griffith, I.F.S., Limond House, Ootacamund, S. India—a daughter (Ann Ellerthorpe).

MARRIAGE.—Mr. R. G. Marriott and Miss Wyatt. The marriage took place quietly on Aug. 18 at the Church of St. Peter ad Vincula, Wisborough Green, Sussex, of Mr. R. G. Marriott, son of the late Rev. George Strickland Marriott and the late Mrs. Marriott, and Miss Janet Sarah Penfold Wyatt, fourth daughter of the late Mr. J. A. P. Wyatt and Mrs. Wyatt, of *Harsfold Manor, Wisborough Green.* The Rev. C. Legard (brother-in-law of the bridegroom) officiated.

The bride, who was given away by her brother-in-law, Colonel C. H. Walsh, wore a dress of delphinium-blue crêpe, with a head-dress and veil of a deeper blue. She carried pink lilies and carnations. Only immediate relatives were invited.

INDIAN FORESTER

DECEMBER, 1938.

EXPERIMENTS WITH EXOTICS

BY R. N. PARKER, I.F.S.

Few activities of the Forest Department seem open to more criticism than experiments with exotics and it must be admitted that much of the criticism is justified. I have heard people go so far as to say they do not believe in exotics. Those who make such statements speak first and think afterwards or probably more often they omit the thinking altogether. The obvious reply is to mention a few exotics, *e.g.*, potatoes, maize, tobacco, etc., and ask which of these they do not believe in. At this point the attack changes its grounds and one is probably told that exotics may be all right for horticulture and agriculture but are all wrong for forestry. This argument overlooks the fact that exotics are already used in Indian Forestry with great success, *e.g.*, Casuarina on the sea coast and mulberry in irrigated plantations.

The objections that should be raised against experiments with exotics should be directed not against exotics in general but at the species selected for the experiments. The fact that a particular plant has done well under certain conditions in a foreign country is no justification for assuming that it will do equally well under totally different conditions in India. Rather one should assume that it will fail.

According to the Kew Bulletin of Miscellaneous Information, April 1936, the Agricultural Department in the Punjab is trying *Spartina townsendii* on saline soil in the Punjab. This grass has done well on the sea coast in temperate climates. Obviously, therefore, it is exceedingly unlikely to thrive in a sub-tropical semi-desert climate. It would not be easy to select conditions more dissimilar than the plains of the Punjab and the sea coast in moist temperate regions and to expect a plant from one of these areas to thrive in the other shows complete ignorance of the requirements of plants. It would be just as reasonable to try mangroves on saline soils in the

desert. Highly specialized plants such as mangroves will not thrive under conditions very different from those to which they have become adapted. It is not, however, for the Forest Department to cast the first stone at anyone in the matter of trying exotics. Some 30 years ago *marram* grass was being tried in the arid rocky hills of the Punjab. The idea seems to have been that since *marram* grass builds up dunes from drifting sand, it would, in some miraculous way, build up soil on rocky hills. It never had the chance to do this since it never grew more than 2 inches high and died apparently from heat and lack of atmospheric humidity.

There are instances, very few and far between, of plants thriving under conditions very different from those of their native habitat. The two best known are perhaps *Broussonetia papyrifera* and *Grevillea robusta,* both plants native of moist tropical areas but which thrive in Upper India. To search for such plants is, however, like hunting for the proverbial needle in a hay-stack. They may be found accidentally as the result of trials of species in Botanic and Horticultural gardens. Practical forestry cannot afford to search for such rarities though it might make use of them when they are discovered.

In trying exotic species in forestry, therefore, it is essential if the search is not to degenerate into aimless experimenting, to select species which are likely to thrive owing to their being natives of countries with a closely similar climate. In comparing climates it is necessary to consider extremes of heat and cold as well as the mean temperature and also the season of rainfall, whether summer rain or winter rain and length of periods without rain as well as the total amount.

Under Indian conditions a successful exotic should usually be one that will regenerate naturally. When one sees the large numbers of exotic weeds that are naturalized in India, one is tempted to ask if the countries that furnished the weeds cannot give us something useful as well. They doubtless can do so but successful weeds are usually very widely distributed in their native countries, either naturally or as a result of cultivation, whereas useful trees are usually much more limited in their distribution and therefore less likely to be generally useful in India and more difficult to place correctly in situations in which they will thrive.

It may be taken as a general rule that a plant that has a wide distribution in its native land is likely to be more adaptable to cultivation in another country than one that has a very limited distribution. One of the most successful and easiest species of *Eucalyptus* to grow in Upper India is *E. rostrata,* a species found in every state in Australia. There are, of course, exceptions to this rule, as *Cupressus macrocarpa* and *Pinus radiata,* both species confined to a small area in California, have been very successful and often regenerate naturally when tried in other countries.

We may now consider a question which is very obvious but which has frequently been overlooked. Are exotic species necessary and desirable? If so, are they wanted in the places where they have been tried and are likely to thrive? If we take the deodar zone in the Himalaya where various species of pine have been tried, the answer to these questions is probably in the negative. No pine produces a timber as useful under Indian conditions as deodar and hence an exotic pine is not wanted in the deodar forests. A pine which would grow on hot, dry slopes where deodar does not grow readily might have a limited use as a nurse for deodar, but otherwise there is no place for a pine. On the other hand, there is a zone in the Himalaya which should be occupied by *Pinus longifolia* and is so occupied where quartzite comes to the surface. Where the geological formation changes to mica schist, these slopes are bare except where the elevation of aspect allows *Pinus excelsa* to grow. A fire-resistant pine such as *Pinus ponderosa,* if it would succeed, would enable these slopes to carry a useful forest growth.

When the Forest Department in the Punjab was experimenting with *Robinia,* it was tried from the plains to 9,000 feet without asking whether it was likely to thrive under all these conditions and without enquiring whether it was wanted throughout this zone. No indigenous tree will thrive from the plains to 9,000 feet and it is unfair to any exotic to expect it to do so. There has been a tendency in the past to expect an exotic to thrive under conditions in which indigenous species have failed. When the exotic also fails, all exotics and experiments with them are discredited. This attitude is most unreasonable but has been very prevalent. It cannot be too strongly emphasised that if an exotic species is worth having, it should be in some respects better than the indigenous species and consequently

it should be worth while, if it is possible to do so, replacing the indigenous plants with the exotic one. Exotics should, therefore, be tried under favourable rather than under unfavourable conditions. To try a useful exotic species in conditions under which indigenous species would fail is merely waste of time. Failure under such conditions gives no information of value. In trying an exotic the object should be to obtain some specimens, the growth and development of which can be watched. If an exotic species fails or does not come up to expectations under favourable conditions, it can be written off as useless and some definite knowledge is gained.

A consideration that is sometimes overlooked is the use that is to be made of an exotic species that can be grown successfully. If it is a tree that is to be used for firewood, no difficulty in marketing is likely to arise. If it is a timber, the marketing of the produce is likely to be difficult. If a few trees of teak or mahogany were available for sale in the Punjab, a satisfactory price could, no doubt, be obtained for them as these timbers are well known. On the other hand, if scantlings cut from half a dozen larch trees were received in a timber depot, they could not be sold on their merits as timber. They would probably be sold as blue pine and not as larch. It would be little use selling them separately as larch if no more were likely to be available for many years. An exotic timber tree, therefore, will have to be grown on a fairly big scale so that a regular supply is available if it is to be sold on its merits as a timber. Timber consumers will have to learn its value before they will pay the full price.

I do not think the term "exotic" has ever been satisfactorily defined and it does not seem capable of a satisfactory definition. Popularly and loosely used, an "exotic" species is one from another country. This is clearly no scientific definition and very unsatisfactory. Under this meaning of the term it might be argued that a Burmese tree grown in India was not an exotic originally but became one on the 1st April 1937. This brings one to the question whether a tree grown slightly outside its natural limits is to be considered an exotic or whether a tree grown in an area inside its natural limits but in a locality where it is not found naturally is an exotic. I do not propose to answer these questions but merely to point out that

many of the objections to exotics apply equally to these cases. Forest Officers who have no respect for exotics do not hesitate to grow a tree either beyond its natural limits or in places where it does not occur naturally. It has been done on a large scale with deodar, in some cases, with not very happy results and in others the ultimate results remain to be seen. Before growing a tree such as deodar in an area where it is not found naturally but within its area of distribution, it is advisable to consider why it is absent. If conditions have changed, through fire protection, for example, an area formerly unable to produce deodar may now be well suited. If, on the other hand, there is no very obvious reason for the absence of deodar in an area where one would expect to find it, there is, at any rate, a possibility that there is a good and satisfactory reason for its absence of which we at present are in complete ignorance. To try to grow deodar under such conditions is, in my opinion, quite as much a gamble as to try an exotic such as larch. We know that larch is absent because the seed has not been able to get there, but the absence of deodar is not due to this cause. I do not wish these remarks to be misunderstood. I am advocating the extensive planting of larch or any other exotic, but merely wish to point out that under certain conditions, if we are not satisfied with the crop nature has given us, an exotic species such as larch, which has been grown in the deodar zone with satisfactory results, is at least as worthy of a trial as deodar. In extending the area of natural distribution of a species, the Cypress appears to be worth attention. Cypress in the Himalaya is widely distributed but of very local occurrence. In former times, presumably, it was more abundant than it is now and has, perhaps, been driven out by competition with other species from most of its former area. If this is the case, its present area could easily be extended. Another case where the trial of exotic species is indicated is the Salt Range. These dry, arid hills are connected with the foothills of the Himalaya and the trans-Indus hills. Their flora has been derived from these sources though climatically they resemble in many respects the hills of Rajputana. From the hills of Rajputana they are separated by a wide expanse of plains with a different flora. It seems possible that the flora of the Rajputana hills is as well suited to the conditions of the Salt Range as the indigenous vegetation and possibly even better suited. This view

merely supposes that since the ice age the Rajputana hill flora has not been able to jump the gap of the plains and colonize the Salt Range. The two chief trees of the Rajputana hills, *Acacia senegal* and *Anogeissus pendula* have both been introduced in the Salt Range area. The former has already shown signs of regenerating naturally in the Pabbi hills where it was first tried.

Finally, there is a case, unfortunately too common in the Punjab and likely to become universal, where, owing to erosion and consequent lowering of the factors of the locality, much of the indigenous vegetation is dying out. The hardier members of the old flora increase and the vegetation takes on a more xerophytic aspect. Protection and remedial action is taken too late to save the original flora in its entirety and we must be content with only its hardiest constituents. In these cases, if a forest crop is to be reconstituted, it is necessary for the more arid and exposed sites to select plants from an area naturally more arid. In the case of the Hoshiarpur Siwaliks, where sowings have been tried, typical Siwalik plants are not used to any great extent. The main species used is *Acacia modesta,* a typical Salt Range plant, which is rare in the Siwalik in undenuded places. Recently *Acacia senegal* from the Rajputana hills has been tried and promises well. It is natural in such cases not to look very far afield for likely species because we know something about species from neighbouring areas and their requirements and can usually obtain the seed without difficulty. There is, however, no real reason to suppose that a species selected from the Rajputana flora is any more suitable than one selected out of the Mexican flora for growing in the Hoshiarpur Siwaliks. A carefully chosen Mexican species might well give just as good results or even better. The Mexican species would, however, have to be carefully chosen, which presupposes some knowledge of the conditions under which it grows in Mexico.

In conclusion, I do not think there is any reason for not experimenting with exotic species provided a little common-sense is used. Firstly, the exotics species should have some quality such as rapid growth, valuable timber, ease of cultivation, etc., which gives it an apparent advantage over the indigenous plants. Secondly, it should come from a climate as similar as possible to that of the locality in which it is to be tried. Thirdly, something should be known of its requirements. It is useless trying a plant from an arid

region under normal arid conditions if the plant in its native habitat is only found growing along streams. Finally, the first trial should naturally be made on a small scale and in an accessible locality or it will be lost sight of. Half a dozen specimens of a likely exotic in the corner of a rest-house compound would show our successors whether the tree was worth a more extensive trial and provide seed for further use if it were required.

* DOES THE ELEPHANT PROCREATE IN CAPTIVITY?

By S. C. Sen Gupta, Veterinary Officer, Andamans.

Summary.—Sir Henry Craik's reference to the fact that an elephant imported in the Andamans gave birth to twins made inquisitive minds in India and abroad to pour queries to the author.

There existed a curious misconception in the minds of the people from ancient days that elephants in their captivity rarely give birth to young ones. The origin of this misconception is not far to seek. The large numbers of elephants employed in those days used to be tied up after their specified work and were not allowed to mix freely with one another so that the processes of breeding might be fulfilled.

In the Andamans, the elephants are breeding frequently. This proves, though not sought for by the authorities, that the old fallacy does not hold good. Even the rule of one calf at a birth has been disproved as an elephant called "Kanakali" gave birth to two sets of twins in two successive pregnancies.

It is, therefore, proposed to discuss here: (1) the part played by elephants in the extraction of timbers; (2) the misconception and its origin, (3) the two factors, viz., freedom and nutrition which are essential for the health and breeding of elephants; (4) the possibility of a balanced ration for the elephants; (5) breed of elephants, pregnancy and parturition and (6) the birth of twins.

Preliminary.—The group of two hundred and four alluring islands of various shapes and sizes, forming the Andamans, cut off from the main land by a vast sheet of watery expanse, has been known to the world since long before the penal settlement was established on its shores by the British Government in 1858. Adventurers, travellers and fortune seekers all have had their turn until, at last, the islands were peopled by the Indian convicts who gradually displaced the native aboriginal tribes.

The picturesqueness of the islands has never failed to impress the mind of even a casual visitor. One cannot help marvelling at the multifarious activities of the administration as well as at the rapid

progress of the varied population. Even Sir Henry Craik, former Home Member to the Government of India, was tempted to bestow the name "Prisoners' Paradise" on the Andamans after his visit to the place. His reference to the fact that an elephant gave birth to twins in this island and the queries received from many people have led the writer to discuss the matter in detail.

The part played by elephants in the extraction of timber.— The timber industry, which was in its infancy in the early days of the Settlement, has gradually developed until at the present moment it is not only the most important industry in the Andamans, but also occupies a distinct place of its own in the domain of the timber industries of the world, and has created a market for the more valuable products of the forest. It cannot be ignored that the part played by elephants is an indispensable factor in the attainment of this phenomenal success. In an article in the Chambers' Journal for May 1931, Mr. James Decie writes:

> "In this age of machinery, it is difficult to realise exactly how much of the world's work is done by elephants. In the forests of Burma and Siam some thousands of these great animals are employed as lumber-jacks by various companies and if their output were translated into terms of plant and machinery, the cost would be very great indeed. The motor-car has ousted the horse nearly all over the world, but the traction engine has not yet ousted the elephant, nor is it likely to do so.
>
> Teak, that is chiefly sought by the lumber companies, grows sparsely in the forest. One tree may be a hundred yards away from its nearest neighbour of the same sort, yet the intervening space is dense jungle. No traction engine, not even a tank, could work under such condition unless roads were made for it. The elephant is the only answer. He can move almost anywhere if the ground is hard enough to bear him. He needs no spare parts and very little oil. He breaks down occasionally, it is true, but he responds readily to medical and surgical treatment. His upkeep is exactly nothing a day, notwithstanding that he consumes seven hundredweights per diem."

These remarks also apply to the Andamans where the forests are quite as dense as, if not more than those of Burma and Siam. Extraction with the aid of buffaloes was tried, found to be expensive

and inefficient and given up in 1923. Mechanical extraction by means of a skidder was abandoned partly because it was not quite suited to the local conditions and partly due to necessity for the extraction of selected species of trees of suitable girths situated at great distance from one another. It is evident that elephants greatly economise the cost of extraction and bring in a higher profit. The work of extraction depends to a great extent upon the health of the elephant and when the health of the elephant suffers the business consequently suffers.

The misconception and its origin.—There existed an orthodox belief from ancient times that elephants rarely procreate in captivity. The origin of this belief is not far to seek. The elephants employed by princes and nobles in India in those days (either for a thrilling hunt or for a gorgeous procession) used to be tied up, after their specified work, to be stall-fed, and they remained in that condition until required for warfare or any other purpose. This constant tethering up did not allow them to mix freely for the purpose of breeding and there were no births. People thus came to believe that elephants in captivity do not procreate. This belief has become so much ingrained in some that they cannot even dream of tame elephants giving birth to young ones and even sometimes to twins where conditions are favourable. In the Andamans, breeding has become pretty frequent though not particularly aimed at. It is observed that sometimes owners of big firms, engaged in the timber industry, have given away at any offer the calves of the working elephants, perhaps owing to the expense of rearing them till fit for work. Calves born in the Andamans of tame elephants have become in their turn, mothers of calves; there is also a pretty large number of calves of ages varying from one to eight. They are not able to do heavy work until they reach the age of twelve; and to prevent them becoming vicious and playful by coming in constant contact with human beings in camps, they are being trained in the dragging of small logs of wood and trucks.

The two factors, viz., freedom and nutrition, which are essential for the health and breeding of elephants.—Freedom allows elephants to enjoy their lives in a natural way and nutrition governs the regular functioning of the whole system and helps in the proper functioning of the genitals. In the Andamans, elephants are set free to wander

about without restraint immediately after they finish their specified work. Care is taken to leave them with bells or wooden clappers suspended from their necks. The sound of the bells or wooden clappers can be heard from a considerable distance in the stillness of the jungle ensuring their ready recovery for work at the next dawn. They also are usually hobbled by short chains attached to the forelegs to limit the movement and a trail chain is tied to one of the limbs which marks their path through the jungle. This freedom in movement is not only a thing of vital importance to their health but it also gives them a chance to breed. It is not possible in their tethered condition to feed them with such a variety of fodder to their satisfaction as they themselves would choose in their free state to their relish. A wild herd has grown up nowadays in the Andamans out of the runaways and released elephants, which is gradually increasing in numbers, and it is not unusual for a wild elephant to take up with a tame female when it is roaming freely in the forest. It is interesting in this connection to know that elephants rarely breed unless they are quite up to the mark in respect of health—a deviation from other domesticated animals.

Besides air and water, the substances indispensable to the nutrition of elephants are many. Of these, the most important are the proteins, carbohydrates, fats, the inorganic elements and vitamins. The vitamins are accessory food factors and are essential to the maintenance of good health. The lack of vitamins in food delays the healing processes of wounds in cases of injuries and predisposes an animal to septicemia, boils and other ailments. The chief inorganic elements are sodium, potassium, calcium, magnesium, phosphorus, iron, copper, manganese, chlorine and iodine. Of these, the following are of outstanding importance for elephants:

Calcium.—This is given to the elephants in a fair quantity and there should be a large margin for waste and non-absorption. Pregnant and young ones specially require it.

Phosphorus.—This plays an important part in all cellular activities and enters largely into the composition of bones and teeth.

Iron.—This is an important constituent of hæmoglobin.

Iodine.—Young and pregnant elephants need more of this element.

The "special powder," prepared by the author, is the richest source of calcium (lime), calcium phosphate (bone-meal), sodium chloride, iron, sulphur, potassium and iodine in graduated proportions.

Common salt (sodium chloride), in moderate quantities, is beneficial to health, because it imparts sapidity to the food, and excites the flow of digestive fluid, but given in excessive doses, it irritates the digestive tract, leading to diarrhœa and general unthriftiness. It is erroneous to believe this to be anthelmintic; for even the stronger drugs given as worm powders, though safe and convenient to administer, are practically useless. The allowance of sodium chloride in the Andaman elephants in quantities is not as important as it is in India, owing to the fact that the islands abound in it almost everywhere within the limit of the grazing area in the shape of saline water, which elephants take to their choice and need. To enrich the ration, every elephant here gets a supplement of the author's "special powder."

The possibility of a balanced ration for the working elephants.— The essential ingredients of complete food are, therefore, the mixtures of intricate chemical compounds obtained from different foodstuffs. In addition to these, a food must contain a certain amount of harmless, indigestible material or roughage to stimulate the intestinal movement; also in the food there are blood-forming substances, extractives, flavouring matter and pigments. No single foodstuff contains these in proper proportions. In practice, to prepare a balanced ration for elephants is an enterprise calling for the exercise of considerable experience, skill and care for general economy. To prepare a balanced ration which requires great expenditure as well as to practise economy is a task of insuperability. For it is not possible to feed elephants with such a variety of fodder that will give them satisfaction, and they, too, do not appreciate any food which is not chosen by themselves. These considerations point to the fact that they should have freedom to graze and select their own fodder. This freedom, apart from giving them a natural life, is conducive to health; so much so, that weak and diseased elephants often recover their health by Nature's cure only, without the intervention of drugs. In the feeding of elephants, therefore, it seems highly desirable that the ration should be computed in accordance with the natural food they get in their wild state. It

is impossible for any synthetic food to equal the stuff that nature provides. The elephant in its natural or wild state lives generally upon herbs, branches of trees, bark, leaves, roots, grasses and so on. In the pursuit of certain grasses which it likes much it travels many miles daily. Yet, what healthier type of elephant exists than the wild specimen?

A full grown elephant requires about a thousand pounds of green fodder daily. In the Andamans, a daily allowance of fifteen to twenty-five pounds of paddy (boiled) together with four ounces of salt and "special powder" is given to all elephants. Over and above these, every hard working elephant gets five pounds of gram (*Cicer arietinum*) in the ration. Gram contains a high percentage of proteins. Germinated gram is given whole. Dry gram contains no vitamins but it develops them during germination and it is easily digested. Elephants here are very fond of *bania* (*Pisonia excelsa*) which is given to them without fear of any harm. Of this tree, they take everything including the trunk. It is important to note that no amount of grain ration will compensate for a continued short allowance of fodder.

Breed of elephants, pregnancy and parturition.—The term "Elephantidae," applied to the various races of elephants, belongs to the genus Elephas. It is divided into two primary groups: (1) *Elephas indicus* or the Indian elephant, and (2) *Elephas africanus* or the African elephant.

The Indian elephant has been classified further as follows according to the individual traits rather than hereditary peculiarities:

I.—Koomeriah, bhadra or thoroughbred.

II.—Mandra.

III.—Dwasala, mirga or half-bred.

The traits of Koomeriah are:

Legs.—Short, specially the hind ones, and colossal; the front pair convex on the front side, from the development of muscles.

Back.—Straight and flat, but sloping from shoulder to tail; hind quarter full and sloping.

Head.—Large and massive.

Chest.—Broad and massive with ribs well set.

Neck.—Short and thick.

Trunk.—Broad at the base and heavy throughout, and of good length.

Eyes.—Full, bright and kindly, without any abnormal discharges and free from opacity. Hump between the eyes prominent.

Cheeks.—Full.

Ears.—Large and free from any discharge.

Forehead.—Broad.

Barrel.—Deep and of great girth.

Skin.—Creased and soft, inclining to fold at the root of the tail.

Tail.—Long, with a line of bristles on both margins at the tip.

Foot-pads.—Flat, thick, tough and springy.

Toe nails.—Smooth, glossy, well set, creamy in appearance, free from cracks and brittleness, and the skin at the root of the nail always moist.

Tusks.—Generally of good shape and narrowing from base to tip with nice curves.

Look.—Graceful, dignified and refined.

Condition.—Hale and hearty.

A Mandra resembles more or less Koomeriah in all respects except that its gait is comparatively slow.

A Dwasala is less excellent than Koomeriah but better than Mirga which is the lowest class of elephants.

The characteristic of Mirga or fourth rate elephants are:

Legs.—Ungracefully lean, long and weakly.

Back.—High arched with prominent spinal ridges, difficult to load, and liable to galling.

Head.—Disproportionate, *i.e.*, either too large or too small for the body.

Chest.—Narrow.

Neck.—Long and thin.

Trunk.—Thin, flabby and pendulous.

Eyes.—Sulky.

Skin.—Hide-bound and thin.

Look.—Ill-tempered.

Condition.—Unthrifty, which no feeding improves.

Besides these, all other defects and bad qualities which can be easily detected are found in Mirga.

Pregnancy.—The duration of pregnancy in the Andamans varies from 545 to 785 days. It has been found that the period of utero-gestation is shorter for female calves and longer in case of males, but "Joy," a female calf, took 785 days, the longest period known among Andaman elephants in the womb of Ma Hlat, the dam. For the twins, the period of utero-gestation has been found to be 599 and 701 days for the first and second sets of twins respectively. The twins at their birth are much smaller than the usual calves that are born one at a birth. Thirty-five inches may be taken as the average height for calves at birth to an elephant that can thrive well.

Parturition.—The following note will give some information about the calving of elephants:

Calves are born sometimes with their hind limbs and sometimes with their forelimbs emerging first. If the hind limbs are seen first, then the calf is generally in a moribund condition or it is still-born. At the time of parturition almost all the elephants become more or less nervous and restless and suffer from labour pains. They seek a well padded soft place for delivery. The elephants at the advanced period of gestation are generally stall-fed at night or allowed to graze close to the camp.

"One calf occurs at a birth as a rule," writes Col. G. H. Evans in his book 'Elephants and Their Diseases.' The birth of twins of the elephant would have been regarded as a freak of nature if it had occurred once only as in the case of the Dionne quintuplets. But the same dam in the Andamans has given birth to twins in two successive gestations to the greatest wonder and admiration of all. I cannot guess what great delight it would have given Sir Henry Craik if he knew it, let alone the public.

Birth of twins—The first set of twins.—Elephant Kanakali, a Bengal (Terai) elephant imported into these islands in 1918, mated on the first of January 1931, at Stewart Sound, North Andaman, with Jung Bahadur, a tusker brought from Burma in 1927. The height of the male at that time was eight feet and four inches and he was 33 years old. The female was 38 years old and measured seven feet eleven inches only. On the 23rd May 1931, she was taken on board the S.L. Montagu-Douglas to Havelock Island for work.

On the 28th August of the same year, her breast appeared to have developed and there was a secretion of watery milk. On the 30th September, the breast was found dried up.

The next year, on the 21st January, she was taken on board the S.L. *Montagu-Douglas* for Middle Andaman from Havelock Island. On the day following, as soon as she got out of the launch, she ran away into the jungle and could not be found till the 28th.

On the 29th, she was engaged in dragging timbers against her will. During the month of July, she showed signs of advanced pregnancy displayed by the distended and pendulous abdomen, reappearance of the shrunken-out mammae and a sluggish gait. In the first week of August, she was taken to the Rest Camp to be stall-fed. On the 16th August, she suffered from labour pains. But all symptoms soon subsided and the elephant showed no signs of immediate parturition.

At 10 a.m. on the 22nd August 1932, she was restless and was assuming postures now and then as if to pass urine. At 11-30 a.m., she delivered a full-grown but still-born bull calf. But it was strange that she again gave indication of labour pain after about half an hour and to the wonder of all she soon gave birth to a female baby. The female calf was taller than the male one. The height of the still-born male was thirty-one inches at the shoulder, and that of the live female was found to be thirty-three inches. The first-born calf was born with its hind legs first (posterior presentation) and the second-born live calf presented its fore parts first (anterior presentation). Birth takes place readily both in the anterior and posterior presentations. But as already stated, the posterior presentation has its drawback in the fact that calves are rarely born alive. The cause of death of the calf in this position is most likely due to the compression of the navel-string, or wide separation of the placental membrane, before the fœtus is able to breathe.

The small size of the live female calf was a great handicap for it; so much so that it was hardly able to reach the teats of the dam to suck milk. When it was given sufficient help to suck the breast, it proved itself too weak to suck. Therefore, it was hand-fed on cow's and goat's milk. But, unfortunately, the calf died at 4 a.m. on the 29th August 1932.

It may be worth noting that the dam was observed shedding tears an hour or so before the death of the calf. Just a few minutes prior to the death of her baby, she broke the chain and made off into the jungle as if she could not bear the sight of her baby dying. Afterwards she was whining away for a long time as if looking for her baby. Thus the first set of twins of the imported elephant in the Andamans was lost.

The particulars of the birth of the first pair of twins are summarized below:

Name of the dam—Kanakali.
„ „ „ sire—Jung Bahadur.
Date of conception—1st January 1931.
„ birth—22nd August 1932.
Interval between two births—Half-an-hour.
Dam imported from—North Bengal (Terai).
Sire imported from—Burma.
Breed of the sire—Koomeriah.
„ „ dam—Dwasala.
Present height of the dam—8 feet.
„ „ „ sire—8 feet and 5 inches.
Duration of utero-gestation—599 days.
Height at birth of the first twin—31 inches.
„ „ second twin—33 inches.
Sex of the first twin—Male.
„ second twin—Female.
Period of life of the first twin—*Nil.*
„ „ second twin—Eight days.

Birth of the second set of twins.—The same elephant, Kanakali, gave birth to her second pair of twins early in the morning of the 19th February 1936 at Lurugic (Baratung Island) in the Middle Andaman. This time both the calves were live females. The twins were rather weak. The one that saw the light first was a bit stronger than the other. As the elephant did not show signs of immediate parturition on the previous day, she was allowed, as usual, to graze near about the camp. Also she did not give vent to much labour pain by groaning or trumpeting. So the details of their birth could not be known. In the morning, however, all were astonished to find

The elephant, "Mo Geme," with her own calf, "Meriel," standing on her left side and the foster-baby, the surviving twin-calf of elephant "Kanakali," standing in front of her, whom the elephant "Mo Geme" is caressing with her trunk.

Photo : B. S. Chengappa.

Kanakali standing beside a puny calf. But what was most surprising was to behold another puny calf standing about a chain away from the dam. The placentæ, two in number, were found lying near the second calf which presumably was the second-born. It was strange to believe that the dam was hostile to her second baby and would not allow it to approach her for a feed. The one fondled by the mother was a little too short to reach the teats to suck satisfactorily. The milk production, too, of the dam was insufficient even to nurse a single one. Great care was taken to enable this calf to suck milk efficiently by raising the ground. The second calf had to be kept on tinned milk as no other fresh milk was available there. To prevent injury to the calf by the dam, care was taken to see that it did not go to the mother. The reason for the dam not allowing two calves to suck milk together was, perhaps, that she could not believe in the two young ones being her own calves.

The elephant, Kanakali, was covered by the tusker Pasha (imported into these Islands on the 23rd November 1927), on the 20th March 1934. At that time, he was 38 years and 4 months old and measured 7 feet and 8½ inches in height.

On the 24th February 1936, the pet baby (first-born) of the dam, unfortunately, breathed its last. The dam then allowed the surviving one gradually to approach her to suck the breast, but milk secretion was insufficient. However, it was extremely fortunate that another elephant, Mo Geme, also with a calf about a month old, with a profuse supply of milk, came to the rescue and acted as a foster-mother to this calf. The two mother elephants had been companions from a long time and this perhaps explains the generosity of Mo Geme. What a grand sight it is to behold both the calves sucking the breast of Mo Geme simultaneously, which gives the appearance of a pair of suckling twins. This act of generosity on the part of Mo Geme is indeed very noble and is analogous to human affection; and, further, this goes to show that attachment is prevalent also among elephants of the same sex and not only among elephants of the opposite sexes. In fact, it has been observed that elephants shed tears at the time of their separation from their companion to a different camp. These may have been due to their reluctance to abandon a spot teeming with memories of a long association. Another side

of an affection of attachment of a male with that of the female has also been revealed in the Andamans. A tusker, named Kharag Bahadur, ran away into the forest and every effort to recapture him proved futile. He joined the wild herd and became one of them. In course of time, the tusker developed "musth" and made his appearance in the sick camp. He had an attachment for a she-elephant called Madho. After an absence of six years, during the "musth," he remembered his old mate Madho and was attracted to her. He therefore led his way towards the sick camp and stood majestically on a stream bed nearby, keeping company with the female elephants in turn. He even came to the camp and shared ration with them, but none ventured to approach him. However, after a great deal of trouble, he was lured into a stockade where the female elephant, Madho, was tied up for the purpose of enticing him, and was captured.

Elephant Kanakali, who gave birth to the two sets of twins, is keeping fit, with one of her surviving calves out of the four. She is now doing a little work in the Middle Andaman, and is under the author's special care. It is hoped that the young ones of the Andaman elephants will prove to be a better class of elephants than their parents in working capabilities as they are being trained both in harness and mouth dragging.

The particulars of the birth of the second set of twins are summarized below:

Name of the dam—Kanakali.
„ „ sire—Pasha.
Date of conception—20th March 1934.
„ birth—19th February 1936.
Interval between two births—Not known.
Dam imported from—North Bengal (Terai).
Sire imported from—Burma.
Breed of the dam—Dwasala.
„ sire—Mandra (Koomeriah).
Present height of the dam—8 feet.
„ „ sire—7 feet and 9 inches.
Duration of utero-gestation—701 days.
Height at birth of the first twin—33 inches.
„ „ second twin.—33 inches.
Sex of the first twin—Female.
„ second twin.—Female.
Period of life of the first twin—Five days.
„ „ second twin—Still alive.

Note.—The author is under obligation to his son, Mr. S. B. Sen Gupta, G. V. Sc., for collecting data and assisting him in various other ways.

CARPENTER BEES

BY C. F. C. BEESON, FOREST ENTOMOLOGIST.

The genus *Xylocopa* or Carpenter Bees, Apidæ.

Xylocopa æstuans.—This carpenter bee is about 7/8ths of an inch long with a wing expanse of $1\frac{3}{4}$ to 2 inches. The head and body in the female are black with a long, bright yellow pubescence on the thorax; the male is entirely covered with a short, dull yellow pubescence, longer on the thorax.

The tunnels are bored by both sexes in dead wood or in timber used in buildings. When crowded, they branch very much without definite arrangement. The larval cell contains a ball of bee-bread about half an inch in diameter and one egg, and is closed by a partition of fine wood-dust amalgamated with viscous saliva; each partition is thinnest near its middle.

This species is occasionally a nuisance in forest rest-houses, boring into roofing rafters, posts and bamboos. It also nests in the dead branches of *Ficus* spp. and *Camellia thea* and in timber depots in old wood of *Cordia grandis, Manglietia caveana, Michelia oblonga, Pterocarpus dalbergioides,* etc.

Xylocopa auripennis.—Frequently uses the internodes of hollow bamboos for its larval cells.

Xylocopa dissimillis.—This is a broad, black bee, resembling the two following species; length $1\frac{1}{4}$ inches, expanse of wings, $2\frac{1}{2}$ to $2\frac{3}{4}$ inches.

Sometimes a nuisance in forest rest-houses, boring into roofing rafters, posts and bamboos.

Xylocopa iridipennis.—Bores the wood of *Adina cordifolia* and bamboo.

Xylocopa latipes.—This carpenter bee is broad-bodied, black and moderately shiny in both sexes; length $1\frac{1}{4}$ inches; the wings are fuscous with metallic blue-green and purple reflections; expanse 3 inches. It is inactive from November to March in the warmer parts of India and for a longer period in the colder regions. It hibernates in tunnels bored in wood, bamboos or reeds.

In timber the bee bores a tunnel that turns downwards in upright or vertical posts and beams, or may turn in any direction

in horizontal beams and logs; the main tunnel may have two to six off-shoots two to four inches long and $\frac{3}{4}$ inch in diameter. The bore of the tunnel is nearly cylindrical, being slightly constricted at intervals to form separate cells. In hollow bamboos of the right diameter, the bee enters at the cut or broken end and makes a single series of cells. At the end of each tunnel, a single egg is laid and a store of bee-bread or pollen is added; the cell is then closed by a partition of fine wood-dust scraped from the sides and amalgamated with saliva. The partition is biconcave, leaving a thin central portion. Other cells are constructed successively above the previous ones.

The egg hatches in warm, moist weather in six or seven days. The larva feeds on the bee-bread and pupates in about three weeks. The pupal period lasts about 15 days and the bee, after a short period of maturation bores out straight to the surface by a separate tunnel or follows that constructed by the mother-bee. The total life-cycle is about six weeks. During this time, the parent bees remain guarding the larval cells or are occupied in constructing additional tunnels.

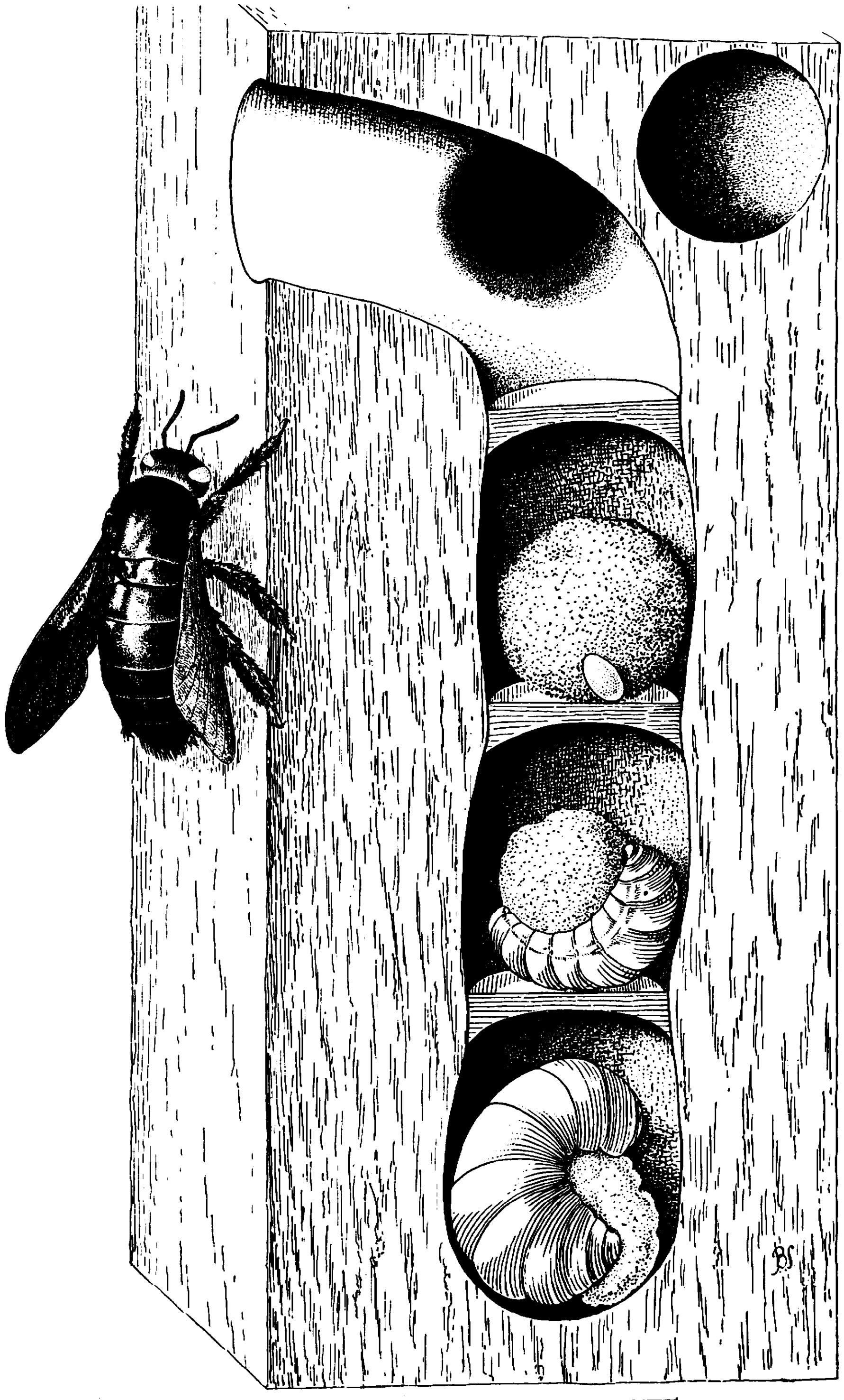
There are four generations or broods between March and November.

This bee attacks constructional timber of the following species, *Amoora wallichii, Dysoxylon hamiltonii, Eugenia jambolana, Cinnamomum glanduliferum* and *Cedrela toona*. It is also recorded as boring holes in lead cables.

Xylocopa tenuiscapa.—Is an all-black, stout-bodied species, closely resembling *latipes*; length $1\frac{1}{4}$ inches; expanse of wings $2\frac{3}{4}$ inches.

Its tunnels are similar to those of *X. latipes*, running parallel to the long axis of the log or beam, about four or five inches long and one inch in diameter with short offshoot tunnels. The larval chamber is provided with a ball of bee-bread half to one inch in diameter, and is closed by a plug of pieces of leaf.

This species attacks *Adina cordifolia, Eugenia jambolana* and bamboos. It is a pest in rest-houses and wooden bungalows attacking rafters and posts and is active throughout the year in south India.



Carpenter Bees.—Gallery of *Xylocopa tenuiscopa* in wood showing egg, larvae and imago.

Xylocopa verticalis.—Makes tunnels in bamboos and in constructional timber of *Duabanga sonneratioides, Michelia champaca, M. oblonga, Morus laevigata* and *Terminalia procera.*

Control Measures.—The bees can be driven away from rooms and verandahs by painting the attacked woodwork with creosote or fuel oil thinned with kerosene; if dichlorobenzene can be obtained, it should be added to the mixture until its odour predominates; the tunnels should be filled or well saturated with the mixtures. The tunnels will probably be tenanted again by bees in subsequent seasons if they are left open, hence it is worth-while filling them up with cement or wooden plugs or any convenient substance other than mud, and creosoting or linseed oiling the whole woodwork regularly each year. Tarring has no deterrent effect after the tar has dried.

MAN-EATER

MAN-EATER

By Abdulgani Mahomed Mandlik.

The following is a literal translation from the original Kanarese of a description by Forester (acting Ranger) Abdulgani Mahomed Mandlik of how he shot a man-eating tiger.

Man-eating tigers are so rare in the Bombay Province that the destruction of this one has added interest.—Ed.

Our North Kanara District is famous for high and thick forests. The southern part of this district, forming Bhatkal Petha, is no exception to this fame. This petha borders on the Madras Presidency and the Mysore State.

A ferocious tiger, which seems to have emigrated from the Madras border into Mysore, killed a villager *en route* to Sagar from Bhatkal, after which it came to be known as a man-eater. The villager neither reached his destination nor returned home. His remains on the way and the depredations of the tiger made it sufficiently clear that it was roaming about in the vicinity of the Bhatkal Petha. Within a short space of three months, seven persons fell victims to this tiger.

The district authorities tried their best to have the tiger destroyed. The tiger was both ferocious and cunning and frustrated all measures adopted for its destruction.

It was ultimately found that the tiger had come to stay permanently in the Bhatkal Petha. There was so much insecurity of life that the poor villagers, who had to go to the jungles for their daily needs, stopped going as they feared that they might add to the toll which the tiger had already taken from amongst them. Even shopkeepers and other townspeople hurried to their homes before dusk

and those who had to wait a little longer would not dare go home without the aid of bright lights, such as petromax, torches, etc. In short, the tiger created a sort of horror among people in several villages bordering the forests.

A villager from Konal was the last man who fell a prey to the tiger on the 23rd February 1938. That very day, the onerous duty of tracing the animal and destroying it fell on me. I was ordered to do so. Immediately, with a few friends of mine, I proceeded to that part of the forest where the man was reported to have been killed, and found, on search being made, a human leg and clear traces of the dead body having been dragged towards a ravine. Beaters were collected without loss of time and that particular portion of the forest was chosen for the beat. The tiger appears to have felt disturbed in its feast over its victim as soon as the beaters howled around. Without the least fear it sprang down over their line and ran away. It was again traced to have lain up in the adjoining patch of forests. The beaters took up that patch for the beat.

There was no time either to arrange a machan or to find a suitable perch upon any tree. With only a forest guard and a villager by my side, I sat on the ground by the side of some bushes. The beating was so arranged that the tiger should pass by my side. Unsuspectful of any danger ahead, the tiger, as per my expectations, passed by the side of the very bushes where we were sitting, within a close range of scarcely 10 yards. No sooner the tiger came within the line of fire than it looked at us and instantly it made a tremendous roar and was about to pounce on us. The precarious position we were then in, the deafening roar and the need of the moment the memory of it all sends a thrill through me even now.

Kill or be killed was the only thought uppermost in my mind. I cannot now imagine the importance of that precarious moment. To lose even a part of a second would have resulted in great danger. I wonder what my two companions were thinking about their own lives and about their families dependent on them and, above all, about me who was responsible for the danger involved.

Whatever it may be, I raised my gun and, aiming at the chest of the tiger fired a shot. Bang! The bullet hit its mark and stunned the tiger. Just when it was about to advance on us, the next bullet finished it.

Thus ended the life of an inter-provincial man-eater measuring 9½ feet with a head so large and ferocious that a mere sight of it would convince of its propensities. It was a pity that no photographer was available till the tiger's carcass began to decompose or else a photograph of it would have shown what a beast it was.

TIMBER PRICE LIST FOR OCTOBER-NOVEMBER 1938

(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or Common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Assam ..	Logs ..	Rs. 30-0-0 per ton in Calcutta.
Benteak ..	*Lagerstrœmia lanceolata*	Bombay ..	Squares ..	Rs. 36-0-0 to 80-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-2-1 to 1-5-0 per c.ft.
Bijasal ..	*Pterocarpus marsupium*	Bombay ..	Logs ..	Rs. 42-0-0 to 84-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-15-7 to 1-3-3 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-4-0 per c. ft.
Blue pine ..	*Pinus excelsa* ..	N. W. F. P.	12′×10″×5″ ..	Rs. 4-5-0 per piece.
,, ..	,, ..	Punjab ..	12′×10″×5″ ..	Rs. 4-10-0 per piece.
Chir ..	*Pinus longifolia* ..	N. W. F. P.	9′×10″×5″ ..	Rs. 1-12-0 per piece.
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	
,, ..	,, ..	U. P. ..	9′×10″×5″ ..	Rs. 3-4-0 per sleeper.
Civit ..	*Swintonia floribunda* ..	Bengal ..	Logs ..	
Deodar ..	*Cedrus deodara* ..	Jhelum ..	Logs ..	
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	Rs. 3-12-0 per piece.
Dhupa ..	*Vateria indica* ..	Madras ..	Logs ..	
Fir ..	*Abies & Picea* spp. ..	Punjab ..	9′×10″×5″ ..	
Gamari ..	*Gmelina arborea* ..	Orissa ..	Logs ..	Rs. 0-10-0 to 1-4-0 per c.ft.
Gurjan ..	*Dipterocarpus* spp. ..	Andamans ..	Squares ..	
,, ..	,, ..	Assam ..	Squares ..	Rs. 50-0-0 per ton.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 30-0-0 to 35-0-0 per ton.
Haldu ..	*Adina cordifolia* ..	Assam ..	Squares ..	Rs. 1-4-0 per c.ft.
,, ..	,, ..	Bombay ..	Squares ..	Rs. 24-0-0 to 68-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-13-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-3-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-10-0 per c.ft
Hopea ..	*Hopea parviflora* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Indian rosewood ..	*Dalbergia latifolia* ..	Bombay ..	Logs ..	Rs. 52-0-0 to 100-0-0 per ton.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 0-14-0 to 1-2-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-12-0 to 1-4-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-9-0 to 2-6-10 per c.ft.
Irul ..	*Xylia xylocarpa* ..	Madras ..	B. G. Sleepers	Rs. 6-0-0 each.
Kindal ..	*Terminalia paniculata* ..	Madras ..	Logs ..	Rs. 1-4-7 to 1-6-0 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 36-0-0 to 72-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-5-0 to 0-12-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 0-14-0 to per c.ft.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	Rs. 1-2-9 to 3-14-0 per piece.
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 25-0-0 to 75-0-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 5-8-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-9-3 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 20-0-0 to 75-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Rs. 0-8-0 to 1-3-0 per c.ft.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-8-0 to 5-0-0 per sleeper.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 1-10-0 per sleeper.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-4-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 1-0-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-14-3 to 5-4-0 per sleeper.
Sandalwood ..	*Santalum album* ..	Madras ..	Billets ..	Rs. 306-0-0 to 639-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Rs. 1-8-0 to 1-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Rs. 0-8-0 to 1-0-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 33-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	Rs. 1-0-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Rs. 0-12-1 to 1-1-10 per piece.
,, ..	,, ..	U. P. ..	Logs ..	Rs. 0-14-0 to 1-6-6 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class	
,, ..	,, ..	,, ..	Logs 2nd class	
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-4-3 to 2-1-11 per c.ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 2-3-3 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 1-14-0 to 2-13-6 per c.ft.
,, ..	,, ..	Bombay ..	Logs ..	Rs. 68-0-0 to 140-0-0 per ton.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 3-14-0 each.
White dhup ..	*Canarium euphyllum* ..	Andamans ..	Logs ..	

THE BLACK POPLARS AND THEIR HYBRIDS CULTIVATED IN BRITAIN

BY G. S. CAUSDALE

(*Oxford University Press*, 3*s*. 6*d*.)

This is a contribution to the solution of the confusion which exists in the nomenclature of the Black Poplars (*Aigeiros* section of the genus). This confusion arises from the appearance of geographical races, spreading and fastigiate forms, mutants, forms exhibiting two-type developments on the same plant, reversions, juvenile and adult forms, forms which have developed asexually, and finally, perhaps, sexual forms.

The black poplars are usually propagated by vegetative cuttings —in many instances only the male or female tree is known to exist— and when sexual reproduction takes place the tracing of the parents of the hybrid is difficult. In one instance, it is suggested that some of the parent species (e.g., *P. alba*) may have ceased to exist as an indigene in England. The facility which attends the crossing of species both within the section and with species of the American Balsam section makes for great difficulty in nomenclature.

Though this work will bring some clarity into the existing confusion of names adopted variously, it is admitted that much more research is necessary before certainty is reached, and new hybrids and forms may still develop.

The difficulty of determining true species or of assigning parents to plants sexually diœcious, and wind pollinated or not, is met with in some Indian genera (e.g., *Diospyros*). It would appear that cross-pollination by insects in species having monœcious or polygamous flowers tends towards the production of purer strains, and in this the selective choice of the insects may play its part.

This booklet arose primarily from an investigation into the poplar canker, as the disease is more vicious in some species or hybrids (e.g., x *P. eugenei*) than in others.

In the detailed descriptions there are some useful silvicultural notes; many are of extremely fast growth, and an instance of a x *P. serotina* (Hartig) is given which was 130 high in 100 years, yielding 1,000 cubic feet of timber.

A market for poplar timber is foreshadowed in the British Isles (one already exists on the Continent), if only sufficient supplies are available. Against their very rapid growth have to be placed their special soil and moisture requirements, and the spacing necessary for their wide-spreading root systems, so that they are therefore "peculiarly adapted for cultivation on lowland farms or estates even if there is no regular woodland."

The artificial key has been compiled by Mr. Beak mainly on the vegetative characters (ciliation of leaf margins, leaf and shoot pubescence, leaf form and habit of growth), and this makes determination difficult when only herbarium material is available. Descriptions are given of nineteen species and hybrids.

Mr. Day remarks in his introduction that "further research is likely to be needed before the mixture of hybrids bearing a great variety of common names can be sorted out, and the most valuable timber producing types recognised."

In India, too, the investigation of local types or races of the more important timber producing trees has received attention, no less than the silvicultural requirements of the species as a whole. Some work has been done in the case of teak and some *Terminalias* by experiments with seeds from widely distanced specimens (geographically) of apparently the same species. It is well known that timbers from these vary greatly with geographical limits, and more than climatic or edaphic conditions warrant, which justifies the division of the species into races, if not varieties, morphologically similar or only slightly variant. Long geographical separation would account for the development of these local characteristics.

R. W. I.

COMMERCIAL MAHOGANIES

SUMMARY

Useful information on timbers of the mahogany class is contained in a publication (Forest Products Research Bulletin No. 18, published by H.M. Stationery Office, London, Price 2/- net), issued by the Department of Scientific and Industrial Research,

The general aim of the publication is to answer some of the enquiries concerning mahogany and allied timbers which have been addressed to the Forest Products Research Laboratory from various quarters of the timber-using industry. It summarises in a convenient form such information as will be useful to timber importers, merchants, architects, manufacturers and users of timber.

Some confusion exists in the mind of the general public as to what constitutes mahogany, a name which has been widely applied, with or without qualification, to a large number of different woods. The term "true mahogany" is generally used to refer to *Swietenia*, the original mahogany of the West Indies and Central America, as distinct from those timbers of the same botanical family which are commonly known by the name of mahogany suitably qualified to indicate the country of origin. In addition to these, there are several unrelated woods of considerable commercial importance which are commonly included in the mahogany class on the ground of quality or custom of the trade. Some of these are used as substitutes for genuine mahogany, while others possess distinctive qualities which enable them to stand on their own merits as furniture woods of the first rank.

The tropical American region is the source of true mahogany, while African mahogany is obtained chiefly from the West African colonies. Other timbers of this class originate in British Guiana, the Philippine Islands and Burma. The notes on the various timbers supply the kind of information which experience has shown to be required by the timber-using industries. The relation between the botanical and the commercial classification of the timbers is emphasised throughout, as a working knowledge of true botanical relationships is often helpful in the practical utilization of timber. Geographical distribution is discussed with special reference to present and future supplies and there is a map showing the principal mahogany-producing countries. Finally, the salient characteristics of the timbers are described. True mahogany, African mahogany and Sapele wood are the usual standards by which other timbers in the mahogany class are judged and accordingly the lesser known woods are compared with one or other of these. No attempt has been made to give a detailed technical description of each timber. The aim has been to summarise the essential points of resemblance and

difference between the various timbers and to describe them accurately enough for the identity of an unknown sample to be verified. Photographs showing the structure of each wood are a useful supplement to the descriptions. The Bulletin is based on the study of a large number of authentic specimens in the extensive wood collection of the Forest Products Research Laboratory. Good use has been made of information supplied by members of the timber trade and officials of the colonial forest departments. There is also a useful bibliography and a check list of trade and vernacular names to facilitate the identification of timbers that may be advertised under unfamiliar names.

MOISTURE IN WOOD

SUMMARY OF FOREST PRODUCTS RESEARCH SPECIAL REPORT NO. 4, "RECENT WORK ON MOISTURE IN WOOD."

(Published by H. M. Stationery Office, price 9d. net.)

The increasing use of wood as a raw material in industry, as distinct from its former principal use as a convenient and ready-made structural material, has revealed the need for further knowledge of the physical properties and behaviour of the wood substance itself, of how these properties are modified when the wood substance is built up into the complex cellular structure of wood which is revealed by the microscope; and of the reasons for the marked changes which occur in wood under varying atmospheric humidities.

For a study such as this the wood substance, though it is a complex material, behaves fundamentally as a colloidal gel whose properties vary in different directions owing mainly to the orderly arrangement of the cellulose molecules within it. The fact that this gel structure has a strong affinity for moisture accounts for the variation in the dimensions and in the strength of wood with the humidity of the atmosphere in which it is placed, as well as for the enormous forces which are brought into play if these natural changes in dimension are restricted.

This report summarises the results of recent research undertaken by the Physics Section of the Forest Products Research Laboratory into the hygroscopic properties of wood and the rôle which

moisture plays in determining the strength and shrinkage of material. Experiments are described which distinguish between two principal types of sorption of water by the wood, *i.e.*, molecular sorption, which is due to the direct affinity of the molecules of water for those of the solid on which it is absorbed, and capillary sorption, which results from the presence of moisture in the small cavities in the sub-microscopic structure or in the anatomical cells themselves. These experiments show that the amounts of water held by both types of sorption vary with the relative humidity and, further, that at any given humidity each type shows a larger sorption on drying than on wetting.

Next, an account is given of experiments in which the shrinkage and the moisture content of very small samples are measured in vacuo in changing humidities. The resulting curves are used to test the conception of shrinkage which the author then presents. Briefly, it is suggested that shrinkage is brought about by a hydrostatic pressure acting on the material which is identical with the thermodynamic swelling pressure deduced by Katz for hygroscopic materials. This pressure acts both on the wood-water aggregate, formed by molecular sorption, and on the capillary spaces in which the capillary moisture is condensed, and it is shown that the effect in these two cases may be seen acting almost independently at low and high humidities respectively. In the latter region, the shrinkage on drying, and the swelling on wetting, are found to be very simply related to the swelling pressure, which is in turn determined by the humidity, so that a quantitative connection exists between the observed shrinkage and the humidity at which it is measured.

Finally, it is pointed out that the graph of swelling pressure, plotted against the shrinkage which it produces, is, in fact, the stress-strain curve of the shrinkage process, from which the resistance of the wood to shrinkage forces at any humidity may be calculated. By comparing this resistance with the results of special mechanical tests on the same species, it is proved to be the same as the resistance of wood to external loads.

EXTRACTS

THE PROMOTION OF PRIVATE FORESTRY IN FINLAND
SUMMARY

On April 17th, 1935, Government appointed a Commission for the purpose, among other things, of examining the question, by what means on the part of forest owners themselves, possibly the payment of imports according to forest area or income from forests, the work of forest owners' associations could best be promoted. The Commission submits its views and suggestions in the present report.

In the introduction the Commission examines the existing position of private forestry in Finland, mainly in regard to the proportion between the quantity of timber felled and the sustained yield. Exact conclusions cannot be drawn in figures, but on the basis of the available felling statistics and data regarding the age classes, distribution of species and timber stock, and in view of the known method and quality of the fellings made in the forests, the Commission has come to the conclusion that the position in the private forests of Finland—taken on an average—is disturbing.

The Commission then reviews the work done for promoting private forestry during 1929—1936. After describing the work of the forestry boards and forest improvement activity, the Commission refers in detail to the origin, development and work of the forest owners' associations. In 1936 the total number of forest owners' associations was 232, their membership 20,632 and the forest area attached to them 1,841,304 hectares. The associations employed 6 university graduate foresters and 232 foremen whose duty it is to look after the members' forests. Close examination shows that the development of the associations stopped when so much forest area had been attached that it was possible to employ a foreman. Membership is far larger among large forest owners than among owners of small-holdings. The finances of the associations are based on an average of approximately 70 per cent. of their own funds and 30 per cent. of Government grants. In general the financial position of the associations is weak. In the present good times, when there is plenty of work offered and rates can be maintained at a high level,

the income possibly just covers the expenditure. But the question arises: how will the associations face bad times in the future? Former experience leads to the assumption that many associations will then be forced to give up their activities. The uncertain future of the associations explains partly, why they have found it difficult to secure capable foremen.

A summary review of the work of the forestry boards and associations proves that the associations have developed into a very considerable factor and that in 1936 their business had already outstripped the business of the forestry boards in extent in many points. The boards and associations together form a single organisation. The Commission regards the advance of the forest owners' associations, which is based principally on the awakening interest of the forest owners and on their own funds, as a development of very great significance.

The Commission then passes on to its proposals. The Commission bases itself on the necessity of adopting highly appropriate measures in order to safeguard and increase the continued yield of privately owned forests and to promote private forestry in every respect.

The Commission does not consider it necessary to try to find new forms for such activity. By a further development of legislation and of the activity that is carried on at present by the individual organisations, it should be possible to do whatever can be done for the private forestry of the country. The object to be aimed at is to get all the private forests of the country included as soon and effectively as possible in the sphere of judicious forestry activity. In the opinion of the Commission this object cannot be attained solely by means of legislation, but an appeal should be made to the initiative and interests of the forest owners themselves. Attention is then devoted to the voluntary activity that has expressed itself in the forest owners' associations of the country.

In laying down the principles for the measures that the present position of private forestry in Finland demands, two lines should be followed principally. On the one hand the law concerning private forests should be extended in such a way that it forms an essential backbone for preserving and improving the value of the forests. On

the other hand the work of improving private forestry should be extended and all private forests should be placed as soon as possible under rational management.

The latter object, which should be treated as the main task, is best achieved, in the opinion of the Commission, through the forest owners' associations. The proposals of the Commission centre round the development and encouragement of the activities of these associations. There are two main problems that require a solution:

(1) In what way can the funds be obtained that are necessary for the extended activities of the forest owners' associations?

(2) By what means can all forest owners be induced to become members of forest owners' associations and derive benefit from the advantages provided by membership?

It would be a simple solution of the money problem for the State to make itself responsible entirely or at any rate to a large extent for the expenditure of the forest owners' associations. The Commission was against adopting this method. The forest owners' associations are mainly the forest owners' own economic societies and the tasks entrusted to the associations are mostly such annual recurring work, the cost of which should undoubtedly be regarded as the regular expenditure on rational forestry. If the costs of managing private forests are transferred to the State, it would mean the abandonment of the principle of personal initiative and responsibility that the forest owners' associations have already adopted with good results and which the Commission regards as one of the most important conditions of successful activity.

In the opinion of the Commission the financing of the work of the associations can be organised best by means of such self-taxation as was indicated by the Government in appointing the Commission. The Commission considers it possible to carry out such taxation and proposes that self-taxation of the forest owners of the country should be introduced and should be called the "forest management tax." The amount yielded by the forest management taxes should be employed for financing the work of the forest owners' associations.

Partly for psychological reasons and partly owing to the fact that obligatory membership would be of little importance, if it were

not made compulsory to employ the functionaries of an association in certain forest work and to obey instructions given, the Commission is convinced that obligatory membership would not prove beneficial. Such compulsory regulations would be difficult to enforce and would lead to very dangerous consequences in practice. In the opinion of the Commission membership in the forest owners' associations should remain voluntary in the future.

The payment of a forest management tax naturally signifies a certain measure of compulsion. However, every citizen is used to paying various taxes and imports for the public weal. Those who pay a forest management tax are in the position through the forest owners' associations of deriving direct benefit from their payment, and it should be possible to presume that forest owners are anxious to participate in such benefits.

Without pressure in some form it will probably be impossible to achieve rational forest management in all private forests within a reasonable time. By private initiative respectable progress has already been made, but the difficulties will probably increase in dealing with the remaining part. Public opinion in this country has not reacted adversely to the more far-reaching intervention that the present law concerning private forests implies, and serious opposition can scarcely be expected if some kind of compulsion is exercised towards those, whose way of dealing with their forest resources leaves most to be desired.

It must, however, be realised that forest owners are opposed to all new taxes and imposts. Such opposition may be expected especially, if the funds collected are devoted to the Treasury in general or to the "promotion of private forestry" as a whole. Owing to the different kinds of forests and their greatly varying yield, the proportion between the available and requisite funds varies in different parts of the country. If the funds collected are placed in a general fund, the regeneration of destroyed forests in some parts of the country, for instance, might easily have to be financed by those parts of the country, in which the forest resources had been well managed and preserved. This would probably provoke justifiable opposition. Under such circumstances the only correct method of procedure would certainly be to devote the funds collected by means of the forest management tax in their entirety to the place where it was levied.

The local forest owners' association should be the organ to receive the funds collected. It can scarcely be imagined that forest owners would not place their confidence in an association that works on their own funds solely for the benefit of the forests of these forest owners. But it is important that the forest owners should be given as much liberty as possible in their association. It is the duty of the Government, of course, to see that the associations obtain the necessary support in their activities, and to a certain extent—especially in regard to the kind of felling done and the auditing of accounts—control must obviously be exercised. But in other respects the self-government of forest owners should be left untouched as far as possible.

Irrespective of the forest management tax the State should continue to support the work of the forest owners' associations directly, though in doing so it is possible to adjust local differences that arise between the amount collected by means of the forest management tax and the funds required. For the requirements of the forestry boards and for the work of forest improvement the State should in future assign funds in the same way as heretofore.

The Commission proposes that the forest management tax should be calculated in such a way that in broad lines it should suffice to pay the wages of the regular forest foremen in the associations, which approximately represent 75 per cent. of the total expenditure of the associations. The Government grant should be about 25 per cent of the expenditure of the associations on an average.

If this method were adopted, it would mean that the State would participate in financing the work of the forest owners' associations in about the same proportion in future as it has done hitherto. The Commission does not consider that the future income of the associations should be restricted solely to the forest management tax and the Government grant, but that the associations should be free to obtain other income. But the forest management tax and the Government grant together should represent the minimum that renders the work possible in any circumstances. Other income would constitute a reserve to be drawn upon as required.

In calculating the amount of money that the forest management tax should yield, the Commission has based itself on the figures established by experience regarding the forest area that can be

calculated per foreman (this figure varies between 8,000 and 20,000 ha) and the annual pay of the foremen. Calculations made on this basis yield the result that the requisite number of foremen is 1,067 and that about 24 million marks are necessary for paying them.

The Commission assumed that 25 per cent. of the expenditure of the associations would be paid by the State. It can therefore be calculated that the share of the Government would amount to about 8 million marks and that the total expenditure of the associations would be about 32 million marks annually. In 1936 the Government contributed about 2.8 million marks to the work of the associations.

The Commission considers it very important that the forest owners' associations should be in a position to provide their foremen with their own living quarters in the same manner as is usual among other employers. The Commission proposes that for a period of 10 years the Government should grant 2.5 million marks annually in support of the forest owners' associations for building houses for foremen. In addition the Government should provide cheap loans for the same purpose. In this way the work of the associations could be supported in a very effective manner.

The Commission has examined the relation of the different classes of forest owners to the forest management tax. The State, which cannot derive any benefit from the forest management tax and which supports the work, the financing of which is under discussion, in other ways, should be released entirely from the forest management tax. The very smallest holdings should also be exempted. Forest land of 5 ha would be a suitable limit. These forests are of small importance and their elimination would represent an appreciable practical gain.

The Commission did not consider it right to place companies, estates and other large forest owners, who employ their own professional staff, on an equality with ordinary private forest owners. On the other hand it seemed desirable that these forest owners should also take part in the work referred to, and it was therefore agreed that these forest owners should pay a quarter of the forest management tax. It is in the interests of the companies owning forests that the private forests in the country should be managed as well as possible, and it therefore seems justified that the companies should contribute in a certain measure to this object. Estates and others of

similar class, as has been proved in practice, have considerable opportunities of deriving benefit from the forest owners' associations, even though they employ their own professional staff.

Three methods may be considered as a basis for the forest management tax:

(1) a tax based on the forest area;

(2) a tax based on income from timber sold;

(3) combined form, in which the tax is based on both forest area and income from sales.

A tax based solely on the area would have the advantage of being closely connected with present forest taxation and thus being fairly simple to work. A tax based on timber sales, on the other hand, possesses the great advantage that the payment of the tax coincides closely with the time of the corresponding income in cash.

A tax based solely on the area is, however, not very suitable for important reasons. In order that the tax should yield as much as is necessary, it would have to be fixed fairly high, and in that case it easily becomes objectionable to the payer. This happens especially, if, for instance, the forest is in such bad condition that no income worth mentioning can be derived from it. Such a situation is not always the consequence of the present owner's measures, in which case the tax might be regarded as a just "punishment," as forest fires, burn-beating and felling done a long time since are often the cause of the condition of the forest. The area tax must also be determined on approximately the same bases every year, irrespective of the general economic position and particularly without taking the state of the timber market into consideration. In taxation according to area it is a very serious circumstance that the proportion of the timber sold to the total yield of timber varies very much on different holdings. Payment of a tax in ready money is much more difficult in the case of small holdings, where the proportion of timber for domestic purposes amounts to 60—80 per cent, than in the case of large holdings. In medium-sized holdings the proportion of timber for domestic purposes already falls to 20—40 per cent.

In taxation, of course, it is necessary to distribute the burden as fairly as possible between individuals and groups of citizens. In the present case, when in addition to collecting money it is also a

case of gaining the good-will of people for the object, such considerations must undoubtedly be fully borne in mind.

The difficulty that exists in regard to the circumstances referred to concerning the fair calculation of the forest management tax can probably be overcome most easily by basing the tax simultaneously on both area and amounts received for sales. That this point of view is right, is evident, among other things, if it is realised, who employs a foreman of a forest owners' association principally. It is the forest owners, who sell timber. Then it is right that they, too, should bear the cost by their income from sales being taxed. But those, who seldom or never sell timber, should not be exempted either, and these forest owners should pay the tax according to area.

The variation according to conditions of trade that a tax based on income from sales implies, is not harmful, for in good years much labour is required, and then funds are available to a corresponding degree. During good years part of the income should be saved in order to assist work during bad years, when, perhaps, not much more than the area tax can be obtained.

The weak point about taxation that is based on income from sales consists, of course, in the difficulty of ascertaining the actual income from sales of all forest owners. In regard to the forest management tax, however, the difficulties should probably be considerably less than in the case of general taxation, as was the case formerly. In the first place the tax would now be considerably less than the former general taxation. In the second, the paid tax is now devoted without deduction to the benefit of the local forest owners. In the third, the possibility of controlling incomes is now appreciably greater—chiefly through the forest owners' associations that are established everywhere.

The Commission proposes that the forest management tax should be based on the area of the forest land parallel with the income derived from sales from the forest. For the category that is based on the forest area the forest management tax can be suitably established on entirely the same basis as the present forest taxation. The category of the tax that is calculated on the basis of income from timber sold should be fixed according to the stumpage price of the timber. The forest owners should be bound to declare such income.

It would be best, if the fixing of the forest management tax were not entrusted to the communal taxation boards. It may be a delicate matter to determine the income from sales of timber and in this respect the composition of the taxation board should often be regarded as rather unsuitable. The Commission has come to the conclusion that the fixing of the forest management tax should be entrusted to a special board. This board should be composed exclusively of forest owners resident within the commune who are liable to the forest management tax. It would be most suitable and convenient to collect the tax in connection with the communal taxes. The cost of fixing and levying the tax should be paid out of the funds yielded by the tax.

The Commission then proceeds to calculate the bases, according to which the forest management tax could be suitably established in order that it should yield the proposed sum of about 24 million marks. The calculations yielded the following results referring to average conditions of trade:

Area tax:

If the tax is fixed at	the yield will be
30 penni per productive m³ ...	... 7.1 million marks
40 " " " " ..	. 9.4 " "
50 " " " " ...	... 11.7 " "

Taxation of income from sales:

1.0 % of income from sales ...	... 8.6 million marks
1.25 " " " " ...	... 10.8 " "
1.50 " " " " ...	... 12.9 " "
1.75 " " " " ...	... 15.1 " "

In the opinion of the Commission the desired sum is most suitably attained according to the following combination:

50 penni per productive cub. metre ...	... 11.7 million marks
1.50 % of income from sales ...	... 12.9 " "
Total	24.6 million marks

On these bases that appear to be suitably rounded off for practical purposes, the forest management tax would be divided in average years approximately half and half between the tax according to area and taxation of income from sales.

The Commission has drawn up comparisons between the calculated yield of the forest management tax and the sums that are calculated to be required in different parts of the country. Adjusting

contributions from public funds appear to be necessary principally in East Finland, Ostrobothnia and North Finland. The forest management tax has also been compared with the fees that existing forest owners' associations charge their members. The forest management tax proposed by the Commission does not imply any increase worth mentioning in the expenditure of those, who are at present members of regularly working forest owners' associations.

The Commission describes the way in which the work of the forest owners' associations has been supported and supervised hitherto by the forestry boards and central forestry societies. Such activity should be further extended according to the experience gained so far. The Commission assumes that, when the forest management tax is introduced, the forestry boards will employ foresters on an ever increasing scale and that such foresters, as leaders in their respective districts, will be established in some suitable central place in the district. On an average 8 foremen should be calculated per district forester.

The Commission finds a further extension necessary of the present organisation in the work of promoting private forestry. This can be done suitably by the forest owners' associations in the territory of each forestry board forming a union and these unions becoming members of the respective central forestry societies. The Commission considers it desirable that the union of forest owners' associations should have an opportunity of electing members to the forestry boards, for in the future the forest owners' associations cannot be passed over, when forest owners have to be represented. Agricultural societies and the central forestry societies should, however, be permitted to retain the right of electing a member each to the forestry boards.

The provision of a suitable staff for the forest owners' associations depends on the trade conditions existing at the time, when the system is introduced. The Commission did not consider it possible to draw up proposals at present for possible steps in this respect, but it is assumed that care will be taken to provide a competent professional staff in sufficient numbers, when the proposals of the Commission are carried into effect. In addition to foremen, the number of foresters should be increased. The Commission considers it appropriate to mention that greater attention should be

devoted to private forestry, especially in practice work, in higher education for forestry.

In conclusion the Commission mentions some considerations with regard to the importance of the forest owners' associations as suppliers of more employment in forestry. It has often been pointed out that forestry should be able to provide more opportunities of earnings and that work for promoting the yield of the forests is one of the most advantageous investments imaginable, for instance, in the case of relief work. Practice has shown, however, that considerable difficulties are encountered in resorting to forest work in such a respect. This is especially the case with regard to work intended to increase the yield of the forests. This is mainly due to the fact that there has been no organisation in existence that had control of all the innumerable small places of employment that the forests provide and that could have distributed the supply of labour that might be available. The Commission considers that through the forest owners' associations such an organisation is provided and that the associations form a very valuable factor that should be reckoned with in the case of possible unemployment. In the opinion of the Commission the considerations referred to provide an addition worth bearing in mind to the arguments brought forward with regard to the proposals for extending the activities of the forest owners' associations.

The Commission has framed its proposals in the form of a special law, entitled "The Forest Management Law." The first part of the law deals with the forest management tax and its collection; the second part with the forest owners' associations and their activities.—*Silva Fennica No.* 45, 1938. *The Promotion of Private Forestry in Finland* (*Summary*).

GERMAN FOREST POLICY AND THE FOREST TREE NURSERIES

By Dr. Kle.

Aims of German Forest Policy.

Germany's present day forest and forestry policy has to face tasks and follow up aims that differ altogether from the State forest policy of former years. With the object of rendering Germany as independent as possible as regards raw materials, a policy she has been forced

to adopt on account of her lack of foreign exchange, the imports of timber, which in the boom year of 1928 amounted to 600 million Reichsmarks, must be greatly reduced and her requirements in timber, that have increased considerably owing to the building boom and the measures of the Four-Year Plan, must be covered to a very great extent from the German forests. At the same time, firewood must constitute a much smaller percentage of Germany's total production (in the year 1936 it was about 45 per cent. of the total production of 25.6 million standards) and the percentage of timber, of which Germany has hitherto had to import 4.12 million standards (1936), must be increased.

These far-reaching aims of Germany's timber trade policy call for the united action of all Germany's forest property, not only that owned by the State and the municipalities, but also that which is privately owned. Germany's forest property is almost equally owned by the various authorities and by private parties. Yet hitherto about 65 per cent. of the production of timber from German forest was covered by the forestry of the State and other public authorities. This divergence between the share of ownership and production shows that privately owned forests, and particularly the woods of the small German farmers, are not so rationally managed and fostered as those owned by the authorities. The State has refrained from intervening in the ownership and exploitation of private forests in order to increase the output, but on the other hand has conferred upon the youngest State authority, the State Forest Commission, under the State Forest Master Field-Marshal Göring, extensive rights of supervision and instruction. Since July 1935, moreover, the State Forest Master has control not only of matters connected with forestry, but also those of the timber economy (relinquished by the Ministry for Agriculture). Forestry and timber economy, forest culture and exploitation—both in State-owned and privately-owned forests—are now treated in Germany on uniform principles as one homogeneous and closely united raw material unit, as regards commercial policy and market regulation.

Running parallel to these organisatory measures since 1933-34 have been the work of extending Germany's forest area by national afforestation, which aims at afforestation of 5 million acres of fallow and waste land, the discontinuation, thanks to the "law prohibiting

the laying waste of woodland," of the wasteful exploitation of German forests, which was frequently done for reasons of speculation, and thirdly, most important of all, the improvement in the quality of Germany's forest holdings. The "law prohibiting the laying waste of woodland," made it the duty of each owner of forest land to re-afforest if the felling exceeded the measure of exploitation prescribed by the Government as a maximum, whilst the "Forstliches Artgesetz" (Forest Species Law) of December 14th, 1934, obliges the owner of the forest or the person enjoying the emoluments derived therefrom to ensure the maintenance and re-culture of high grade characteristics of the stock of the German forest and the extirpation of inferior growths and individual trees, by destroying weaklings, unproductive, crooked and frail stems and stock and by using for the re-afforestation (at first of certain kinds of trees) only the so-called "certified seed" from forest nurseries and seed nurseries that have been granted express permission to grow seeds and plants.

Effect of the re-incorporation of Austria.

Since this re-organisation of forest economy, however, an event has occurred that has greatly influenced the basis of German timber supply, namely, the re-incorporation of Austria. This latest acquisition to German territory, in which quite 37 per cent. of the soil is woodland, has a larger proportion of woodland than the older German territory (27 per cent.). But, unlike the rest of the country, this woodland property is not half in the hands of private owners and half in those of the authorities, but only 28 per cent. is State-owned and 72 per cent. privately owned, and though with its 7.75 million acres it is about a quarter as extensive as the woodland of the old Reich, it produces only one-sixth of the quantity of timber. Yet Austria had difficulty in suitably exploiting this timber crop; she exported timber, and just as much of the important converted coniferous timber as Germany had to import (the fir tree may be called "The German timber tree"). The incorporation into the German Reich, therefore, means a perceptible relief for both Germany and Austria. But, on the other hand, we must take into consideration the fact that now, in the carrying out of the Four-Year Plan (Hermann Göring Reichsworks at Linz, standard motor-car roads, land settlement schemes, work service camps, etc.), which has also been

extended to this youngest German territory, Austria will herself require far more timber than before. It is, therefore, evident that the German State measures already initiated in order to increase the output of the German forests will not only have become superfluous since Austria joined Germany, but, on the contrary, will also have to be extended to include Austria.

This state and these aims of Germany's forest policy, which in turn render the organisatory and legislative measures since 1933-34 intelligible, had to be briefly mentioned in order to make clear the reason for the increased importance to be attached to-day in Germany to the forest and seed nurseries as the only authorised suppliers of seeds and forest plants.

Organisation of Germany's Forest Nursery Growths

Germany's well-considered and uncompromising forest economy is characterised by the determination to create a healthy mixing of the woodland stock and by the determination to grow those trees which, after careful tests, have shown to be strongest and most productive in the respective soils and in the respective climates. Therefore, an ordered forest economy requires the inclusion of the forest plant nurseries in the comprehensive regulation of this branch of economics, as this alone ensures the production of recognisedly high grade seed. These nurseries, therefore, as the necessary preliminary stage of forest economy, have also been included in the German regulation of the forest economic market. The only recognised and executive organisation of the cultivating firms is the "Reichsverband der Forstpflanzenzüchter, Plants and Seed Nurseries, of which every cultivator and distributor of forest plants and every seed nurseryman, every full-time and part-time forest cultivator, must be a member. It is his duty "to make to the Reichsnährstand (Central Organisation of Agriculture and Allied Industry and Commerce), suggestions as to the regulation of production, the turnover and the prices and price margins for forest plants and forest seeds, and to communicate to the members of his firm the regulations issued by the Reichsnährstand for the adjustment of the production, turnover and the prices and price margins for the products of the cultivators of forest plants and the seed nurseries, and to see that these regulations are carried out." The Reichsnährstand, on the other hand, is authorised by law "to issue instructions for the production of forest plants, to regulate the commercial sale and to fix economically suitable prices and price margins for the products of these firms."

The extraordinary neglect of the interests of forest economy in Germany since the end of the war, the lack of an adequate right of the State to interfere with and to instruct private owners of woodland,

and the administrative splitting up of German forestry into a dozen and a half independent subsidiary State administrations naturally led to a serious reduction in the quality and productive capacity of the German forests, and just as naturally put the forest tree nurseries into the constantly increasing danger of having their existence absolutely destroyed. But their collapse would have led in the subsequent years to the most disadvantageous consequences for the German forest economy, especially in so far as the forests are in private hands and do not rely on their own nurseries. Reciprocally, the one depends on the other. It was Germany's national work of afforestation with its large orders, the inclusion in the market regulation scheme and the granting of "economically suitable" prices that gradually restored to the German forest tree and seed nurseries their economic lucrativeness along with a gradual improvement in their turnover.

A Double Economic Risk.

Hitherto, the German forest tree nurseries have in two respects borne a great economic risk; in the first place there is a seasonal trade very much exposed to climatic influences, and secondly, it takes four or five years for them to turn over their stock, and for that period they must estimate in advance both the kinds and the quantities of plants required. A faulty estimate, *i.e.*, a turnover that fails to come up to expectations, means, however, not only a corresponding falling off of profits, but almost invariably a total loss, because after a four or five years period the products of the forest tree nursery can no longer be transplanted, nor can they be warehoused. They are then absolutely worthless and there is no alternative but to burn them all. This compulsion often arose in the former German forest economy with small orders that could not be estimated in advance even over a period of but a few years. In the year 1933 the threatened economic collapse of the German cultivation of forest trees in the nurseries could only be avoided by a short-term credit of 1.3 million Reichsmarks granted by the Reich in order to bridge over the difficulties. True, it is not a numerically large calling, for Germany has in all about 180 to 200 forestry tree nurseries, in addition to about 1,000 to 1,200 forest-plant firms and about 70 or 80 seed nurseries, their annual turnover being about 1,200 to 1,500 million Reichsmarks. But the fact must not be lost sight of that the quality of their products is decisive for the quality and output capacity of the forests, and that the economic value of the forests is not merely the 600 or 700 Reichsmarks yeilded "ex-forest" by the stockwood felled, but also the 4,000 to 5,000 million Reichsmarks realised from the raw material wood by processes of treatment. But this increase in value is only imaginable and possible if a forest yields something more than firewood, *i.e.*, if the forest plant nurseries, as the first link in the chain, produce high and prolific seed and plantation material. Therein lies their political-economic

importance, which just nowadays is so very great for Germany, namely, to place at the disposal of Germany's forest economy that replanting material which, in the management of the forests, will make it possible to reduce the share of the less valuable firewood and to produce in increasing quantities high grade timber from the various kinds of trees, suitable for the various purposes.

Work-giving Enterprises.

In Central Germany, in the surroundings of Halle an der Saale, in South Westphalia and in Würtemberg there are fairly large numbers of forest tree nurseries, but 70 per cent. of Germany's total turnover falls to the share of the comparatively small area of South Holstein, to the north of Hamburg, which may even be called the centre of the European forest and garden tree culture. From here 800 to 900 million plants are sent out every year. As the State cultivates her own plants in her own forest gardens, the chief customers are the private, and particularly the small forest holdings. For the forest tree nurseries (as contrasted with the garden tree nurseries, which cultivate ornamental shrubs, standard rose trees, avenue and park trees, etc., and often export them to distant lands) it is very agreeable that they encounter hardly any foreign competition. In order to get them accustomed to the climate, even those exotic trees that stand in the German forests first have to be accustomed to the climate, and cultivated in German nurseries. Experiments with the direct importation of foreign products (even from the Austrian Alps to the north of Germany), have proved a failure over and over again. For the same reason, the German forest tree nurseries, on the other hand, do not export on anything like the same scale as the garden tree nurseries.

The tree nurseries provide a very great amount of work. An ordinary medium-sized tree nursery of from 80 to 100 acres usually provides work for about 25 assistant workers on the soil and a smaller number in the adjoining forwarding department. But not all tree nurseries carry on a forwarding business at the same time; the smaller firms, in particular, frequently rest content with the cultures, frequently of special sorts, which are then sold to the neighbouring large cultivators and forwarders. It, therefore, very often happens that in the course of time a hired worker makes himself independent as a cultivator on his small savings. He depends on his capabilities as an expert and his long experience of the work, but leaves to the larger forwarding business the risk of commercial activities. This division of labour has proved highly satisfactory. The expenses of the tree nurseries for materials are small, sometimes only seeds are bought and the seedlings cultivated from them. Cost of implements hardly counts at all. Of late, there have been expenses for wages in spring and autumn for the additional workers, mostly women and girls, who are taken from other districts.

The following information is taken from the accounts relating to the *Seaborne Trade and Navigation of British India* for September 1938:

IMPORTS

ARTICLES	MONTH OF SEPTEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
Siam ..	14	136	18	1,747	15,983	2,540
Burma ..	..	11,202	12,660	..	16,44,959	17,38,762
French Indo-China	104	651	107	12,050	80,688	13,006
Java .	76	501	540	10,185	64,515	34,920
Other countries ..	..	..	1	..	..	..
Total ..	194	12,490	13,325	23,932	18,06,145	17,89,228
Other than Teak—						
Softwoods ..	946	449	1,071	58,281	33,540	62,529
Matchwoods ..	818	650	417	44,125	41,004	26,391
Unspecified (value)	..	..	..	43,601	2,26,347	1,93,215
Firewood ..	20	32	142	300	480	1,225
Sandalwood ..	26	34	..	7,778	5,045	150
Total value ..	..	..	..	1,54,085	3,06,416	2,83,510
Total value of Wood and Timber ..	..	..	..	1,78,017	21,12,561	20,72,738
Manufactures of Wood and Timber—						
Furniture and cabinetware ..		No data			No data	
Sleepers of wood ..	..	78	16	..	15,593	2,865
Plywood ..	206	118	161	50,337	17,658	52,561
Other manufactures of wood (value) ..	..	..	..	90,814	1,25,963	1,05,808
Total value of Manufactures of Wood and Timber other than Furniture and Cabinetware ..	..	..	..	1,41,151	1,59,214	1,61,234
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	12,199	15,129	15,957	86,076	1,22,471	1,65,048

EXPORTS

ARTICLES	MONTH OF SEPTEMBER					
	QUANTITY (CUBIC TONS)			VALUE (RUPEES)		
	1936	1937	1938	1936	1937	1938
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	3,699	39	..	7,50,473	5,337	..
„ Germany ..	265	..	..	67,062	..	..
„ Iraq ..	38	..	11	6,798	60	2,640
„ Ceylon ..	109	..	..	13,508	46	..
„ Union of South Africa ..	782	..	..	1,67,650	..	..
„ Portuguese East Africa ..	181	..	..	31,296	..	..
„ United States of America ..	201	..	..	59,420	..	..
„ Other countries	365	73	107	85,090	19,738	41,555
Total ..	5,640	112	118	11,81,297	25,181	44,195
Teak keys (tons) ..	347	..	..	46,591	..	..
Hardwoods other than teak ..	195	7	..	19,354	1,700	..
Unspecified (value)	..	..	..	35,210	54,664	8,235
Firewood ..	..	..	..	..	..	..
Total value ..	..	..	..	1,01,155	56,364	8,235
Sandalwood—						
To United Kingdom	2	7	..	2,000	6,880	5
„ Japan ..	15	10	1	39,303	10,010	1,380
„ United States of America ..	50	100	50	50,000	1,00,000	50,000
„ Other countries	22	3	17	26,270	3,929	17,330
Total ..	89	120	68	1,17,573	1,20,819	68,715
Total value of Wood and Timber ..	..	..	..	14,00,025	2,02,364	1,21,145
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	6,851	23,372	51,086
Other Products of Wood and Timber	No data			No data		